Pacific Fisheries Resource Conservation Council
Conseil pour la Conservation des Ressources Halieutiques du Pacifique

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Freshwater Habitat
Chapter 1: Introduction

Salmon and steelhead habitats in British Columbia are almost as varied as the province's geography. The rich biological diversity of species and stocks of salmonids — the family to which salmon and steelhead belong — is an evolutionary response to the physical and chemical variability of the habitats in which these fish live. Furthermore, the formation and maintenance of the habitat is linked to the extant biology, accompany this phenomenon.

Throughout our province, the consequences of these processes can be seen from the spawning and rearing of coho in the smallest of rivulets, to pink salmon spawning in the vast fields of gravel in the mainstem Fraser River. In British Columbia, almost any water flowing in the direction of the Pacific Ocean is in some way salmonid habitat; this is because of the strong habitat linkages from a watershed's headwaters to the sea. The ways the habitat in the upper reaches of a watershed are impacted by human activities or by nature can profoundly affect habitats in the lower reaches.

As long as the integrity of these processes remains intact and harvest is not excessive, salmonids are generally resilient and can cope with the challenges they face in nature. They will come back to spawn, year after year, in abundant numbers. However, we often see declines in fish populations when humans disrupt the complex framework of natural processes upon which salmon depend. Such interventions include disturbance of the physical and chemical constituents of habitat, and the negative impacts of urban development, forestry, mining, hydro-electric power production, agriculture, and fishing.

Managing, protecting and restoring salmon and steelhead habitat is a complex and difficult endeavour. First, while the recognition of some kinds of salmon habitat is straightforward and obvious — such as the sockeye spawning beds in the world-famous Adams River — other critical habitats, like a farmer's ditch in the upper Fraser Valley which may contribute important food resources to a small population of coho living downstream, are not often recognized.

How we, as a society, protect salmon and steelhead habitat, and whether or not we are doing a good job of it, is also not well understood by British Columbians. Part of the problem lies in the fact that we really do not know how to manage salmonid habitat. Much of the science and technology surrounding habitat management, protection and restoration is less than a decade old. It is a young and evolving science; there is still much to learn and many well-intentioned mistakes are made. Action to protect salmon habitat often means that habitat should simply be left alone and undeveloped, an action that is often not palatable in "tight economic times." Protection of fish habitat becomes increasingly difficult as human economies continue to depend on high levels of growth. This is relevant to local salmon populations as well as global

ecosystems.

The demands that British Columbians place on the resources connected to salmon and steelhead habitat — such as land, trees, and water for hydro-electric power and human consumption — often conflict with salmonid well-being. The short term economic pressures to compromise salmon habitat for the sake of human development are enormous. When we hear of a "win-win" situation for fish habitat and development, it often means another incremental loss of salmonid habitat.

Nevertheless, the general public expects government at a variety of levels to move in directions that foster better management, protection and restoration of salmon habitat. Indeed, there is now a complex maze of governmental legislation, regulation and initiative that provide the framework for how habitat is managed. Some of these initiatives are neutral, while some produce superlative results. However, it is also true that some of this effort hinders protection of habitat.

The following sections of this report discuss the attempts that British Columbians are making in the effort to protect and manage salmon habitat. They also describe the relevant legislation, policy and regulation, science and technology, as well as government and "stakeholder" initiatives. These efforts are placed within the broader context of the biological and physical parameters that constitute salmon and steelhead habitat.

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Instream or "Wetted" Habitat

Instream or "wetted" habitat is that component of freshwater salmonid habitat that lies within the watered edges of a stream or lake, as opposed to riparian and upland habitats that are also important for salmonids. Instream habitat for anadromous salmonids includes a host of macro-environments, from small streams and sloughs to large rivers, ponds and very large lakes. In this section of the report we also include the estuary — that highly-productive transition zone between freshwater and true-ocean waters.

The use of the instream environment by various salmonid species is very complex, and is still only partly understood by scientists and naturalists. For any one of the macro-habitat categories (river, lake, pond, etc.), each species and each life-history stage of salmonids also use specific micro-habitats, and require particular depths, water velocities and substrate-sizes. There may also be between-species overlaps in these micro-habitat requirements and, as a result, significant inter-specific competition can occur to resolve these similarities of use.

In order to set the stage of how salmon and steelhead habitat in British Columbia is managed, what follows is a brief description of our understanding of the complexities that constitute freshwater habitat for these species. (Marine habitat issues will be dealt with in a separate chapter of the PFRCC's report.)

Streams

British Columbia has an estimated 430,000 streams comprising a total linear distance of 793,000 kilometers. Sea-going salmon and steelhead can be found in many of these waters, from the very smallest of streams to the very large Fraser and Skeena Rivers.

Stream flow conveys very specific advantages to the various life-history stages of salmonids. For example, spawning fish, and fertilized eggs buried in stream-bed gravel, benefit greatly from moving water. The flow helps move gravel when the female is digging her nest or "redd," and also helps to fertilize eggs during the

spawning event. The currents percolate through the gravel, washing oxygen over the embryos and larvae, which keeps them alive while they develop into small, completely-formed and free-swimming, juvenile fish. Once they emerge from the gravel, juvenile salmonids may or may not rear in the stream environment for some time before going to sea, depending on the particular species and stock of salmon or steelhead. The time spent in freshwater can range from a few hours to many years.

The benefits of moving water for these stream-rearing salmonids are many. The flow of water acts as a food-conveyor of insects for the fish living in the streams, which is an energy-efficient way for the salmon or steelhead young to obtain food. Stream flow distributes nutrients and leaf litter that provide the basis for insect production throughout a watershed. Streams also provide a highway for migrating fish, either for adults moving upstream, juveniles moving to other feeding locations or overwintering areas, or sea-going young moving downstream.

The power of the water and its movement are vital in the development and maintenance of fish habitat. For example, flowing water is critical in providing a supply of fresh gravel for spawning habitat, and it also washes out fine silts that can clog spawning redds. Stream flow will wash boulders, large logs and woody debris into a stream, which provides important hiding habitats for juvenile fish, and also physically stabilizes the stream bed. The erosive energy of streams can also create new side channels for young fish to rear in, and removes deleterious sediments from substrates used by rearing insects.

Many of these physical processes occur when a stream is in flood. Although damage can be done when floods destroy spawning redds and flush small fish out of the stream during high-water events, the energy and movement of the water is important to keep the stream ecosystem in a dynamic equilibrium. While habitat may be destroyed during natural flood events, habitat is also created. On average, the energy of the water ensures a long-term balance by maintaining a consistent abundance and quality of rearing habitat.

An important component of stream habitat is the pattern of water deployment through the watershed over time. Hydrologists and fisheries biologists use the term "hydrograph" to describe the distribution of a stream's discharge over a year. Various salmon and steelhead populations are evolutionarily adapted to the way that water is conveyed through their various stream environments. A disruption in patterns — either too much or too little water at the wrong time of the year — can devastate fish populations.

Lakes and Stillwater Habitats

British Columbia is extraordinarily rich in lakes. These water bodies range tremendously in size. Some are so small and shallow that they do not appear on topographical maps, and can be referred to as ponds or sloughs. Some are large, deep, glacier-fed water bodies, such as Harrison, Shuswap, Chilko and Quesnel lakes. These stillwater habitats are critical to the survival and production of some species of salmonids. Notably, lakes are important for the rearing of most populations of young sockeye salmon. The juveniles of the world-famous sockeye runs to the Adams and Horsefly rivers live in Shuswap and Quesnel lakes for a year before migrating to sea.

Some populations of juvenile coho and chinook also use the perimeters of lakes for rearing. They tend not to use open waters, but rather a lake's shoreline or "littoral zone." Coho fry are particularly well-suited to rear

in very small lakes and beaver ponds. Chum salmon, pink salmon, and steelhead do not use lakes to any extent for spawning or rearing, although some populations of these species use lakes in their migration routes. While most salmon require a stream to incubate their eggs, some populations of sockeye salmon will actually spawn in lakes, relying upon groundwater flowing through clean gravel.

Not all lakes are equal in their ability to produce smolts — juvenile salmon that are large enough and physiologically ready to go to sea. Production within lake-nursery environments is constrained by temperature, by nutrients such as nitrogen and phosphorus, by other species of fish which may be competitors or predators, and by basin topography and hydrology. Lakes in warmer and relatively nutrient-rich southern latitudes tend to produce more and bigger sockeye smolts compared to lakes in more northerly watersheds. In northern lakes, fry normally remain an extra year in order to reach a size that is large enough to begin their encounters with the perils of an ocean life.

Estuaries: The Link Between Freshwater and Marine Habitats

Estuaries are among the richest and most productive ecosystems on earth. However, estuaries comprise less than three percent of the entire British Columbia coastline. It has been suggested that the biological-productivity values of the Fraser River estuary and the associated Boundary Bay area are at the "high end" of the range for values reported for such habitats anywhere in the world. Almost 90 different species of fish have been found within the Fraser River estuary. Of these, about a third are truly "estuarine," meaning that they do not go to either wholly freshwater or marine environments at any time of their lives.

The mixing of fresh and saltwater and the associated nutrient dynamics and intense biological production in estuaries provide some of the richest salmon habitats in the province. All species of juvenile salmon benefit from this rich habitat as they migrate from fresh to marine waters, but chum and chinook salmon profit in particular from the estuary's intense food production. Chum salmon normally reside in the Lower Fraser River estuary for a number of weeks before moving on to saltwater. Similarly, some populations of chinook are known to spend as much as three months in the Fraser River estuary before heading to sea.

Because of their usefulness as marine transportation centres, and because of the richness of the soil and the flatness of the terrain, estuarine areas on the BC coast have been particularly attractive to industrial and residential development, agriculture, shipping and log storage. All these activities require some degree of diking, dredging and land-fill. Many of the historical estuarine habitats in British Columbia have been severely impacted by human activities. For example, it has been estimated that 82 percent of the Fraser River's salt marsh has been lost in recent times. Other, highly productive estuaries have been perturbed by humans to varying degrees. Estuary loss on the Cowichan River is estimated to be 53 percent, and the Squamish and Nanaimo estuaries have been reduced by at least half.

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Only in the last few decades have fisheries managers come to appreciate how much the riparian or "transition zone," between the wetted perimeter and the upland areas of lakes and streams, is of critical importance to fish habitat. It is now clearly established that this is not sufficient to protect the integrity of the wetted portion of the stream itself. The maintenance of the vegetation and landscape adjacent to the water is also vital for the sustainability and production of fish, as well as for the protection of salmon and steelhead habitat.

A healthy riparian area along streams and lakes, which normally includes abundant vegetation, performs several functions. It aids in maintaining water quality by acting as a filter of sediments and pollutants; assists in temperature modification by providing shade; provides the stream with large organic debris which is vital to the development of instream habitat; provides the stream with small organic debris, such as leaves and needles, which are eaten by insects. A vegetated riparian area also inhibits erosion during floods by stabilizing stream banks with a network of plant roots, and these plants can provide a forage base for fish from the insects which live in the canopy and drop into the stream. In northern watersheds, shoreline vegetation helps moderate freezing of the stream during the winter.

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The upslope or upland portion of a watershed encompasses those areas not immediately adjacent to, or within, the wetted perimeter of a stream or lake. It is a part of the watershed that also influences the sustainability and productivity of salmon and steelhead populations and must be considered when discussing habitat protection and management.

The instream, riparian, and upslope habitats are intimately interconnected. For example, the upslope areas of a watershed initially define many of the conditions that fish will encounter in a stream, including: hydrology or flow patterns; temperature regimes; the types and concentrations of nutrients that will enter the water; and whether or not fine sediments have the opportunity to be entrained into the aquatic ecosystem.

The human activities that affect the upslope portion of the habitat include forestry, urbanization and agriculture. For example, prior to the enactment of the *Forest Practices Code*, coastal streams were routinely affected by a high incidence of landslides and debris-flows due to improper road building, or logging on inappropriately steep terrain. Likewise, during urban development the landscape is normally stripped of most vegetation and new watercourses are established which changes natural flow patterns. It has been estimated that if more than 20 percent of a landscape is stripped of its vegetation, the flow regime disruptions are readily observed. These disruptions include more rapid run-off and higher water yields — conditions to which the local populations of salmon may not be adapted.

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Salmon and steelhead are cold-blooded organisms. Their growth and development rates are a function of the temperature of the water in which they exist. Unlike warm-blooded animals, the development speed of incubating salmonid embryos is an almost direct linear function of the ambient water temperature; that is, within the constraints of the ranges of maximum and minimum lethal-temperature boundaries, the higher the temperature, the faster the development.

Likewise, the rates of growth by juvenile fish below and above the optimum temperatures show a very curvilinear relationship, with about 15 or 16 degrees centigrade being the apex of the growth function for most salmonids. Once the temperatures reach the low to mid-20s, mortality begins to occur in these species, starting with a weakened resistance to disease, and ending with abrupt death at the highest temperatures.

Thus, any changes to the temperature regime in streams and lakes under which a population of salmonids has evolved will potentially affect that population's survival and production rates. Because streams and lakes with anadromous salmonids in British Columbia are located in the mid-latitudes of their North American range, they tend to be cooler when compared to the habitats of most of the more southerly populations of these species. It has been argued that many of the salmon populations in British Columbia are constrained to lower production as a result of this. Nevertheless, there are clearly some human-caused environmental impacts which have changed temperature regimes and caused stress and mortality to fish living in streams in British Columbia.

Water may be excessively warmed when riparian vegetation is removed from the upslope areas and/or riparian areas, and when inappropriate amounts of water are withdrawn or diverted for hydro-electric power, domestic consumption or agriculture. These situations tend to occur in the southern interior, the Lower Mainland, and on Vancouver Island, during the summer months when water levels are low and human-caused perturbations are already exacerbating unfavourable habitat conditions.

An example of a situation in British Columbia where human intervention causes adverse impacts on stream

temperatures is that of the Nechako River. Here damming has reduced the normal discharge regime encountered by sockeye salmon migrating towards Stuart Lake. When high summer water temperatures occur in the Nechako River during the migration period, the Aluminum Company of Canada works with fisheries agencies to mitigate these temperature effects by releasing cool waters into the river. However, historic observations suggest that without greater cool-water release flows, adult salmon on their spawning runs will encounter a much higher mortality rate than otherwise. This issue attracted a high profile during the deliberations by the public, governments and Alcan on whether or not to finish the Kemano Completion Project. This project was canceled on August 5, 1997 by agreement between the province and Alcan.

Conversely, cold-water releases from low-level outlets in water-storage reservoirs can also limit production of salmon and steelhead in streams. Reservoirs and lakes normally tend to stratify into temperature regimes, with colder, denser layers at the bottom, and warmer, lighter layers at the surface. However, when a river is dammed, an artificial lake is formed, and when the water is released from the bottom, the temperatures can be lower than optimum for fish growth. The Capilano River is a probable example of this phenomenon.

The Role of Nutrients

Many of British Columbia's fish-bearing watersheds are relatively nutrient-poor because of high rainfall and a geology that is intrinsically low in nitrogen and/or phosphorus. These elements are the two primary nutrients that nourish stream and lake ecosystems, in the same way that they allow backyard vegetable gardens to flourish.

In river environments, nutrients are used by algae on the stream bottom. Many species of insects eat these algae, and are in turn eaten by juvenile salmonids. How many fish are produced, and how quickly they grow, are partly functions of insect abundance, which can depend upon algae production. The ultimate fate of the nutrients in a stream depends upon how quickly they are recycled through the aquatic ecosystem. Normally, the flow of nutrients is in a downstream direction, and there is a generalized recycling of nitrogen and phosphorus from water to algae to insect to fish, and then back into the water again, via fish feces or the decay of organisms after they die.

In lakes, these nutrients are utilized by phytoplankton — microscopic, suspended algae — and other tiny organisms, such as bacteria. These are eaten by very small zooplankton — microscopic invertebrates. These tiny animals, in turn, are fed upon by larger zooplankton, which are prey to a multitude of different species of fish, including young sockeye salmon. Some species of fish, including sockeye fry, are very efficient at eating these very small organisms.

In lakes, nutrients are normally removed very rapidly from the water by algae and bacteria, which store nutrients in the form of cellular constituents. Nutrients are also stored in the form of invertebrates or fish as they are cycled up the food chain. However, these critical nutrients are eventually lost to production, either by dropping out of the water column onto the substrate at the bottom of the lake, or by being washed out via the outlet stream. Nutrients can also be "exported" from an aquatic ecosystem as a result of overfishing.

Even in nutrient-poor waters large runs of salmon can be found involving those species that require extended rearing in freshwater before going to sea (such as sockeye, coho, and steelhead). Scientists have

now found that many of these high-production salmon populations appear to be functioning on marine-derived nutrients. Strong evidence exists for this in the work of scientists who have traced certain elements (stable isotopes) through the food chains of these populations. Over long periods of time, the large waves of fish coming back from the Pacific Ocean have brought with them nitrogen and phosphorus incorporated into the bodies of the adult salmon from food that they had eaten in marine environments. The nutrients are released into bodies of freshwater and into surrounding landscapes when fish carcasses decay, and also when they are eaten by scavengers and predators. The marine-derived chemical constituents then become temporarily stored in the aquatic and terrestrial ecosystems of the watershed, to be released slowly as natural biological and physical processes take place.

The export of these nutrients from the aquatic environment often does not happen in the space of a year, and can take many decades as they are recycled continually within a watershed. Nevertheless, in the highly-productive but nutrient-poor sockeye lakes, nitrogen and phosphorus must be regularly replaced or replenished, in the same way that a battery must be recharged.

Recent studies suggests that chronic overfishing, combined with large-scale habitat destruction, has caused significant declines in salmon and steelhead production due to the exhaustion of marine-derived nutrients. Salmon contribute nitrogen and phosphorus to the ecosystems enclosing their spawning grounds at a rate of three percent nitrogen and three percent phosphorus of wet body weight.

In the latter half of the 19th century, salmon and steelhead numbers in British Columbia were probably close to the natural carrying capacity of their freshwater habitats. In the late 1800s, the first large-scale human impacts on salmon stocks began to occur as a result of industrialized fishing and logging. It has been suggested by scientists that these two industries, acting in concert, began to influence the historical distribution and abundance of salmon by intensively intercepting marine-derived nutrients, and at the same time, by destroying habitat through poor logging practices.

The removal of nutrients and carbon sources in freshwater environments, caused by overfishing, is a major source of potential productivity losses. The two-fold impact on habitat and nutrient-recruitment initiates a subtle and little-understood "negative feedback loop" on freshwater productivity. This "loop" is now more than a century in progress, and many salmon and steelhead stocks in British Columbia are consequently thought to be depressed at least partly as a result of this poorly-understood phenomenon. The response to this by the Department of Fisheries and Oceans, and the BC Ministry of Environment, Lands and Parks, has been to fertilize particular streams and lakes, sometimes with great success, lending strong credence to these scientific hypotheses.

The Role of Gravel

Gravel is usually the primary inorganic-physical component defining the morphology, or shape, of a salmon or steelhead stream. The amount and the grain-size of gravel in flowing waters is a function of the local geology and topography, the local hydrology, and human impacts and influences on the stream and surrounding riparian and upslope areas.

The size and abundance of gravel is important for the production of salmon and steelhead for a variety of

reasons. First and foremost is that salmonids are adapted to spawn in gravel. Generally, the larger the individual fish of a species, the larger the gravel it chooses to build its nest or redd. Fine sediments mixed in with the gravel, or deposited upon it, can reduce the survival of the embryos and larval salmon by limiting the amount of oxygen-carrying water flowing through the gravel. Fine sediments can also prevent the small fry from swimming out of the gravel when they are ready to become free swimming, by acting as a "cap" when they are deposited on the surface of the redd. These fine sediments include sand, silt and clays.

Gravel is also important for the production of food for fish. It provides a surface upon which algae attach and grow, and algae is in turn be eaten by insects which in turn are eaten by fish. Sand and finer substrates in salmonid streams are usually poor at producing desirable insects for fish to feed upon.

Finally, the larger fractions of gravel, and cobble and boulders, are often used as cover and protection by a wide range of fish to hide from predators and competitors. One method of producing instream-fish habitat used by fisheries-restoration biologists is to place clusters of boulders in the water to provide this physical cover.

Human intervention can affect the availability of gravel in a salmonid stream. Where a dam has been constructed on a river, it can often stop the movement of fresh gravel downstream to important spawning areas either by trapping the material in the upstream impounded areas, or by reducing the downstream flows which are required to scour new material from the stream banks. Examples of rivers in British Columbia that have been affected in this manner include the Alouette, the Stave, the Capilano, and the Campbell. However, this is only a short list of the total. Some of these streams have been treated by restoration projects which have attempted to replace some of this lost gravel. Likewise, gravel mining, either for the aggregate industry, or to protect property from flooding by providing stream-channel freeboard, can cause significant impacts upon fish habitat, as is the case with the Coquitlam, Fraser and Vedder rivers.

The Role of Large Organic Debris

Large organic debris (LOD), or large woody debris (LWD) as it is also known, provides some of the most important fish habitat in salmon and steelhead streams. It provides cover for fish in the form of logjams, root-wads, and overhanging sweepers. LOD also stabilizes stream beds by trapping gravel for spawning, and dissipates the energy of stream flows. It also helps to trap the carcasses of spawned salmon and other organic material, such as leaves, which are important sources of food and nutrients for algae and insects.

LOD is classified as woody material that is greater than ten centimeters in diameter and two meters in length. Normally LOD enters the stream channel as a result of natural stream-bank undercutting, windfall, and natural slope failures. Much of the LOD in BC streams has disappeared over the last 100 years due to the activities of logging and clearcutting to the stream bank, as well as stream-cleaning for flood control and navigation. Because the wood which makes up LOD is so sizeable, it will take centuries before many British Columbia streams have a natural and "normal" recruitment of this material again. When mature and old-growth riparian forests are removed or reduced by clearing, either for urban development, agriculture, or in logging operations, the large wood in the stream is lost at about ten percent per decade, with only the submerged wood remaining. New conifers take 150-200 years to grow and "re-supply" streams, and most deciduous trees are too small and decay too fast to be of much consequence, either to habitat capacity, or

stock productivity and survival rates.

Less than two decades ago, fisheries agencies were still promoting the removal of (LOD) from salmon and steelhead rivers in an enthusiasm for producing stream bottoms that were "clear and clean" for the migration, spawning and rearing of fish. However, some fisheries agencies are starting to intervene with artificially constructed instream LOD structures to replace this important component of habitat.

The Effects of Elevated Total Gas Pressure

Fish are subject to the dissolved-gas conditions of their surrounding aquatic environments. When the dissolved air in the water is elevated above normal hydrostatic concentrations, either through natural or man-made means, there can be both lethal and sub-lethal affects on aquatic organisms. Elevated Total Gas Pressure (TGP) is commonly found downstream of waterfalls and dam spillways where there is a deep plunge pool into which the water cascades. In these cases, elevated TGP occurs when air is physically forced into solution above normal saturation. The entrainment of air into water normally occurs at dam sites when there is so much inflow that the facility has to spill the excess water over the top of the dam into the plunge pool rather than putting it through turbines. Lake or reservoir surface waters can also contain elevated levels of TGP due to solar warming.

Fish respiring in water containing elevated Total Gas Pressure (TGP) can experience a phenomenon somewhat like a diver's "bends," in which gases come out of solution in the blood as the fish approaches the surface of the water. The resulting affect, termed Gas Bubble Trauma (GBT), can be quickly lethal, or the impacts can be subtle and drawn out. Regardless of the time frame, GBT can nevertheless still cause impacts upon fish health and population productivity. GBT is often referred to as the "silent killer," because the occurrence of an elevated TGP episode is often during a high-water flood, when it is not easy to identify a mortality event, and the fish bodies are quickly washed away from the scene of impact.

At some dams, hydro-electric companies are able to reduce the chances that elevated TGP episodes will occur. Depending on the configuration of the facility, water can sometimes be passed through ports or gates which allow a reduced plunge to the pool, and result in a lower elevation of TGP.

The Department of Fisheries and Oceans, and the Ministry of Environment, Lands and Parks, suggest that to protect the aquatic environment, levels should not be allowed to exceed supersaturation of 103 percent for water less than one meter and 110 percent for water greater than a meter in depth. More work has to be undertaken to refine these guidelines.

The Role of the Natural Hydrograph

The graphic quantification of the flow of water in a stream over a period of time is known as a hydrograph. The average discharge of water from any given watershed has a spatial and temporal consistency in volume and pattern. These patterns may vary significantly between streams, so that two watersheds with similar average flows might still have very different hydrographs.

Depending on the geographic location and the type of stream, hydrographic patterns show regular trends

from day to day, season to season, and year to year. In the winter, coastal streams tend to show more variability in flow than do interior streams. Groundwater-fed streams, meanwhile, have a high degree of discharge stability, while rain-driven and snowpack-driven streams can fluctuate wildly. Small streams tend to have a higher rate of change, whereas large streams have a much slower rate. Flows during spring runoff will normally be much greater than late summer discharges for any given stream. Even though the flow of a stream may not be known at any given point in time, the probability of a particular discharge for a given date of the calendar year can be numerically estimated and shown to follow a predictable pattern.

In recent years, there has been mounting scientific evidence that a functional relationship exists between the health of an aquatic ecosystem and its natural hydrograph. Production of salmon and steelhead is often reduced when the discharges are disrupted from normal patterns, because salmonids are adapted to particular flow regimes and behave in certain ways based on historic average discharges through a normal year. That is, flow-response behaviours have a strong genetic influence on salmonids. As a result, the average behaviour and the subsequent survival and production of an individual fish, or a population of fish, is specifically tuned to the timing of the discharge of a stream, its rate of change, and its volume. What follows are some examples of how this works.

In the spring, for many salmonid streams, the melting snow starts flooding the landscape as the flows begin to increase. At the same time, the young salmon and steelhead fry are leaving the protection of their gravel nests. As the rivers leave their normal maximum bank-elevations and inundate the riparian areas, recently-emerged fry gain access to food in the form of terrestrial insects and other items which may not otherwise be available.

Adult fish also often migrate during a flood event, when higher water levels provide passage to areas which may otherwise be difficult to reach for spawning due to obstacles that are present at lower discharges. Floods also help create new habitat by scouring out gravel and by making fresh spawning beds, by eroding trees into the stream for the recruitment of large organic debris (LOD), by eroding new shallow side-channels within which small fish may rear, and by recruiting the all-important nutrients and leaf litter into the channel to be used as food for invertebrates. The quality and quantity of fish habitat in streams appear to be partly a function of the shape and amplitude of the discharge hydrograph.

The natural hydrograph can be disrupted by human activities in a variety of different ways, including: damming a stream for hydro-electric power or domestic and industrial water supplies; over-abstraction and diversion of water for irrigation, domestic and industrial uses; excessive commercial and urban development which "hardens" the landscape by creating impermeable surfaces, and disrupts flow patterns through culverting and storm-drain sewers; channelization, flattening and draining of agricultural land to increase crop production; excessive ground-cover removal (i.e. logging), which changes the snow-melting rate and also disrupts the innate sponge-like water-holding capacity of the landscape.

Recognizing that the productivity of salmon and steelhead is linked to the hydrograph is an important part in developing safeguards and restoration plans for streams. For the protection of fish in watersheds, the order of hierarchy in flow patterns is as follows:

- **Base flows:** Minimum amounts of water must be present in the stream in order for any aquatic life to survive.

- **Among-seasonal flow variability:** Life history stages of salmonid species require the seasonally-specific discharge regimes to which they are adapted. Too much or too little water at the wrong time of the year can cause adverse impacts upon fish survival.

- **Within-seasonal flow variability:** For anadromous salmonids, the consistency of flows is important. Nevertheless, there is also a relationship between the long-term health of an aquatic ecosystem and a normal frequency of rare and large flood events and drought events. This relationship is not clearly understood for most stream ecosystems, but is still considered to be a basic requirement. These lower-probability events sustain fish habitats in the long run (extra-large floods recruit spawning gravels, wash out silt, create off-channel habitats, recruit large organic debris, etc.) although they do cause apparent short-term "damage."

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Freshwater Habitat
Chapter 3: Species of Salmon and Steelhead in British Columbia and their Individual Habitat Requirements

SALMON SPECIES
Sockeye
Pink
Chum
Chinook
Coho
Steelhead

Sockeye

The sockeye is perhaps the most well known of the Pacific salmon species and is distributed throughout many of the larger watersheds in British Columbia. Most populations of sockeye spawn in streams that are closely associated with lakes, although some stocks spawn within lakes where there are groundwater-rich gravel beds. Lake residence is normally a requirement for the rearing of the fry, for one and sometimes three years, before these young fish smolt and go to sea. There are rare populations of sockeye that do not require lake rearing of the juveniles and instead go almost directly to the ocean as fry.

The most productive sockeye watershed in British Columbia is the Fraser River, with the largest producers of sockeye being the Adams, Horsefly and Chilko watersheds. The Skeena River watershed also has some very large populations of sockeye, and there are some smaller stocks throughout Vancouver Island and the Central Coast, such as the Great Central Lake and Owikeeno Lake populations, respectively, which have contributed significantly to fisheries. The Nass River, north of the Skeena drainage, also supports strong sockeye runs.

Because most sockeye populations tend to spawn and rear in parts of British Columbia that are away from urban centres, many of the habitat impacts affecting other species have not been felt by sockeye. Nevertheless, there have been some large perturbations over the time of the European settlement in British Columbia which have had a significant impact on sockeye production. Perhaps the most notable was the massive rock slide at Hell's Gate on the Fraser River, which impeded the migration pathway of millions of fish for many decades. A joint venture with the United States in the 1930s resulted in fishways being built at this site. This has allowed at least a partial rebuilding of some of the sockeye stocks in the Fraser River.

Habitat impact on the production of sockeye includes the industrial clear-cutting of forests in the watersheds of some of the Fraser River's more productive populations. Of particular concern are the fish in the Stuart and Horsefly Rivers.

Perhaps one of the most overlooked sources of habitat damage has been the lack of adequate escapement,

not only to seed the spawning grounds with fertilized eggs, but to provide the all-important micro-nutrients of nitrogen and phosphorus in order to ensure plankton growth in sockeye-rearing lakes. Over the past 20 years, the Department of Fisheries and Oceans has been artificially increasing production of sockeye through lake fertilization. These efforts mitigate some of the losses of nutrients that are no longer available to populations with depressed escapements.

Pink

Pink salmon are the most numerically abundant species of Pacific salmon in British Columbia, and it can be argued that they have the simplest life history among salmon species. Because they have no prolonged freshwater rearing period — they go directly to sea once the fry have left the spawning beds — the predominant habitat features that seem to be critical to their survival and production include an abundance of gravel and relatively stable flows during the incubation period. Pink salmon populations often fluctuate in escapement returns. This is probably because they are sensitive to flow regimes during the development of the embryos in the gravel. They have a strict two-year life cycle which does not buffer the spawning populations from temporary environmental or man-made impacts to their habitat.

Pink salmon spawn in a wide range of watershed sizes, from very small streams to the mainstem of the Fraser River. While pink salmon spawning in the larger streams of the province seem to have weathered many habitat impacts, many populations in the smaller streams have become extinct. The construction of dams seems to be particularly hard on pink salmon runs. Nevertheless, they are quick to re-colonize areas where they had been extirpated, if given an appropriate opportunity, as demonstrated by the recovery of some pink salmon runs upstream of Hell's Gate on the Fraser River, following the construction of fishways.

In their own right, pink salmon can be seen as an important habitat feature. The mass spawning exhibited by many pink populations provides a rich source of carbon, nitrogen and phosphorus, which are important nutrients for the productivity of many of our normally nutrient-poor, coastal freshwater ecosystems. While pinks, with their almost non-existent freshwater rearing, don't entirely benefit from this nutrient input, they are considered to be a "keystone species" because so many other organisms within these ecosystems, both terrestrial and aquatic, are dependent upon them for this effect.

Chum

Chum salmon spawn in streams along the length of the coast of British Columbia, but normally do not migrate very far inland. Chum normally spawn in small to medium sized streams, but in the large Harrison and Fraser Rivers they tend to be drawn to their groundwater-fed side channels. Because of their propensity to seek out and use groundwater-sourced discharges, which are somewhat independent of surface flows, chum are often able to utilize habitats that other species are not. These include backwater sloughs, or highly perturbed areas downstream of dams where normal discharge regimes have been severely disrupted. Ironically, while pink salmon populations often become extinct below dams, chums frequently survive, as they have downstream of dams on the Stave and Cheakamus rivers. Nevertheless, because chum tend to spawn in lowland areas where human activities are particularly intense, chum populations have a higher extinction rate than many of the other species of salmon.

Like pinks, chum salmon also do not spend much time in freshwater after the fry leave the spawning nests. They normally migrate downstream soon after emergence from the stream bed. Many chum populations utilize estuaries before going to sea. The Fraser and Squamish estuaries are two examples of heavy utilization by chum salmon.

Like pink salmon, chum salmon populations often spawn in relatively large numbers, and by providing large amounts of marine-derived nutrients and proteins, they make important contributions to the health of aquatic and terrestrial ecosystems. In some populations, their sizable numbers and relatively larger body sizes allow chum salmon to excavate large volumes of gravel from stream banks during the spawning event, which helps maintain and expand spawning beds. Their spawning activity tends to move redd-clogging sediments out of the gravel. Chum salmon have been observed to play an important role in restoring their own spawning habitat.

Chinook

Chinook have one of the most variable life history patterns of all the Pacific salmon species. In British Columbia, some populations of chinook salmon start spawning as early as July, while others can still be reproducing as late as December. Chinook juveniles can be found rearing in streams, lakes, and beaver ponds, for a few days or weeks, or up to a year or more before they go to sea. Other populations of chinook go directly to estuaries and spend several months there before leaving for the sea.

Chinook also have the broadest geographic range of any salmon in British Columbia. In the Fraser River watershed, chinook salmon can be found spawning in the large Harrison River, just above tidal influence, to Tete Jaune in the uppermost parts of the river, more than 1,000 kilometers from the sea. Chinook salmon tend to use larger rivers for spawning than do most other species, but can also be found in smaller tributaries such as the Coldwater River and Spius Creek in the Nicola-Thompson drainage. Other notable populations in British Columbia can be found in the Campbell and Stamp rivers on Vancouver Island, the Shuswap and Nechako rivers on the Fraser, the Atnarko and Bella Coola rivers on the central coast, and throughout the Skeena River watershed.

Over-exploitation has probably been one of the most important causes of chinook declines in British Columbia since the arrival of Europeans. Chinook tend to be quite well "buffered" from habitat degradation due to the fact that they are inclined to spawn in large and remote rivers that are less susceptible to human activities. Nevertheless, these same large rivers which supported substantial chinook populations, although some distance from human population centres, were also coveted by electricity interests. These rivers were dammed for hydro-electric power in the early to middle part of this century. They include the Alouette, Coquitlam, Cheakamus, Bridge, Nechako, Puntledge and Campbell rivers, which now have chinook populations that are mere remnants compared to historical escapements.

Major chinook-rearing wetlands, such as on the Fraser and the Squamish, have suffered substantial human-caused losses, which in turn have resulted in extremely adverse impacts on their chinook-rearing capability. In addition, some of the smaller chinook rivers, such as the Horsefly and the Coldwater, have been affected by land clearing for logging, agriculture and the development of transportation corridors. Some highly productive chinook streams, such as the Nicola and the Bonaparte, have been damaged by intensive

agricultural-water withdrawals.

Coho

Coho salmon in British Columbia tend to spawn and rear in streams along the coastline, although there are interior populations on both the Skeena and Fraser River watersheds. Coho are the most difficult of the salmon species to observe in freshwater as they are a very shy and secretive fish. For the most part, they prefer to spawn and rear in diminutive and innocuous waterways, and these often include the smaller tributary streams of our larger watersheds. The Salmon River, flowing through Langley, and Black Creek, on Vancouver Island's east coast, are examples of some of British Columbia's more productive coho streams. Interior Fraser River coho tributaries include the Deadman and Nicola, while Toboggan Creek on the Skeena River watershed is a more northerly population.

Coho fry normally spend at least one year in freshwater, although sometimes two years, before migrating to the ocean. Beaver ponds, small lakes, and small streams with relatively slow waters are favourite rearing areas for this species. In lowland areas, streams that have been transformed into drainage ditches sometimes rear extraordinary numbers of these small fish. The estuary environment does not appear to be an important component of coho rearing habitat.

Coho have probably suffered the most of the salmon species from over-exploitation as well as habitat degradation. Because they are a lowland and small-stream species associated with areas where settlers first developed agriculture and built cities, coho are often the first salmon species to disappear through extinction. In these areas, coho salmon habitat has become homogenized through diking, ditching and channelization, and almost all the important natural-flow patterns and hydrographs, to which this species is subject and adapted to, have been disrupted.

Steelhead

Steelhead spawn and rear throughout many of the medium to large streams along the coast and the interior of British Columbia. Nevertheless, they are often associated with large streams, such as the Skeena and the Thompson rivers, where they are caught by anglers on their migratory routes. Well known steelhead streams in British Columbia include: the Vedder/Chilliwack, Nicola, Bonaparte, and Chilko rivers in the Fraser watershed; the Stamp, Gold and Campbell rivers on Vancouver Island; the Dean and Bella Coola on the central coast; the Morice and Bulkley rivers in the Skeena River watershed.

Steelhead in British Columbia often rear in freshwater streams for two or three years. Because of this extended period of rearing in freshwater environments, steelhead are particularly vulnerable to adverse habitat impacts. Their instream habitat requirements are quite specific, and change as the juvenile fish gets larger. Normally, steelhead fry require shallow, slow-moving water, but they move into faster and deeper water as they grow before leaving to the sea as smolts.

Industrial-level logging has probably perturbed more steelhead habitat than any other human activity, and this is the case in watersheds such as the Vedder/Chilliwack, the Chehalis, the Squamish, and the Salmon River on Vancouver Island. The damming of streams, for hydro-electricity and for domestic water supplies, is

probably the second most disruptive habitat impact for this species. Dams have been built on steelhead streams such as the Coquitlam, Capilano, Stave, Cheakamus, Alouette, Puntledge and Campbell. Some interior stocks of fish are also affected by water withdrawal for agriculture. This is the case for streams such as the Nicola, Deadman, Bonaparte and Coldwater.

Species of sea-going Pacific salmon, *Onchorhynchus,* in British Columbia and their macro-habitat requirements

Name	Freshwater	Estuary	Marine
coho *O. kisutch*	Often spawns in small streams; prefers rearing in small-stream, wetland & small-lake habitats for one, sometimes two, years of juvenile rearing	Minimum of estuary rearing	1/2 to 1 1/2 years in salt water, with some fish taking an extra year; often rearing in marine waters close to continental North America
pink *O. gorbuscha*	Prefers gravel rich streams, usually medium size to very large rivers; no stream rearing	Very short residence time while passing from fresh to salt waters, minimum ofe stuary rearing	Has a strict two-year life cycle; north of upper Georgia Strait has both even and odd years with even year dominant, south has only odd year runs; marine rearing tends to be high seas
chum *O. keta*	Spawns in small to large streams, is particularly drawn to groundwater; normally has a short freshwater rearing phase, usually only a few days to weeks	Fry extensively use estuary where available before migrating to sea	Normally these fish live in the sea for 2 1/2 to 4 1/2 years; marine rearing tends to be off-shore in the high seas
chinook *O. tshawytscha*	Tends to spawn in large rivers often downstream of lakes; freshwater life-history is extremely variable ranging from a few days in freshwater, to estuary rearing for some months, to multiple years in freshwater lakes or streams	Some populations extensively use estuaries, usually for about three months as fry before going to sea	Spends the most variable time rearing in marine environments of the salmon, from a few months to over five years; marine rearing is both off-shore and close to continental North America
sockeye *O. nerka*	Usually spawns in streams associated with lakes; lake rearing of fry to smolts is normally one year before going to sea although this may vary	Very little rearing in the estuary	Spends 1 1/2 to 3 1/2 years in in marine environments, a four-year total life-span is the norm but some populations are highly variable from this; high seas marine rearing
steelhead*	Tend to spawn in medium to	Very little rearing	1 1/2 or 2 1/2 years of ocean

O. mykiss	small streams; juveniles may spend up to four years in stream-rearing environments before migrating to Sea	in the estuary	rearing is the norm but this can vary; steelhead can spawn multiple times unlike the other Pacific salmon; marine rearing is in the high seas

* Formerly steelhead trout (*Salmo gairdneri*), it is now taxonomically included with the Pacific salmon (Genus: *Oncorhynchus;* species: *mykiss*). British Columbia is also host to another smaller anadromous salmon species, cutthroat trout (*Oncorhynchus clarki*), which we do not consider in detail in this work.

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Effective measures to manage, protect and restore salmon and steelhead habitat require a clear understanding of what constitutes habitat, how much of it exists, and how much has existed, historically. This information must be determined scientifically as well as by inventory and assessment initiatives.

While the understanding of what constitutes salmonid habitat is certainly not complete, and has progressed unevenly over the years, the current state of inventory and assessment of the habitat resource has increased exponentially in the last two decades. This is due in part to the recognition by management agencies and stakeholders that comprehensive data are required in order to rationally plan and manage a fisheries resource in a sustainable manner. It is only with scientifically defensible information that good habitat decisions can be made.

Some recent government-driven initiatives tied to the Salmonid Enhancement Program, the Aboriginal Fisheries Strategy, Forest Renewal BC initiatives and the associated *Forest Practices Code* regulations, have considerably expanded knowledge about salmon habitats in British Columbia. Furthermore, there has also been public support and the political will for funding very large adaptive-management experiments which have given habitat managers a better understanding of the functional response by ecosystems to specific changes. The following sections outline and review some of the more important data bases and initiatives used in British Columbia to manage habitat.

Fish Habitat Inventory and Information Program (FHIIP)

The Fish Habitat Inventory and Information Program (FHIIP) is a joint federal and provincial program that provides up-to-date information about fish bearing streams and lakes throughout British Columbia and the Yukon. Through the efforts of this initiative, there is information on about 12,000 waterbodies in British

Columbia currently, although not all of these waterbodies necessarily contain salmon or steelhead.

FHIIP has collected information from a large body of sources, including non-government organizations, consulting reports, agency files, etc. These data have been entered into the electronic file known as the Fisheries Information Summary System (FISS) for use by professionals, agencies, First Nations, industry and others. The data can be accessed through the Internet using the addresses: **http://habitat.pac.dfo.ca** or **http://www.elp.gov.bc.ca/fsh/ids/dman/FISS/**. The FISS database also allows for the use of Geographical Information System software to provide mapping of the information.

The FISS has been in development for some time. Its precursor was the Stream Information Summary System (SISS). The genesis of SISS began in the 1980s when it was recognized that the information base on salmon habitat in British Columbia was sorely lacking. In 1982, Peter Pearse, Commissioner of the Commission on Pacific Fisheries Policy, made the following statement "...the government of Canada should invite the government of British Columbia to participate in a joint program aimed at compiling a comprehensive inventory of fish habitats in freshwater streams and estuaries in British Columbia. The inventory should describe the biophysical characteristics of individual areas of fish habitat, and should include an assessment of their potential for producing fish...."

Pearse's observations on habitat included the statement that the Department of Fisheries and Oceans "...knows surprisingly little about the present quality of fish habitats in the Pacific Region or their ability to support fish....to date the Department has made no comprehensive inventory of habitat in the region." Pearse was concerned that the lack of data affected planning and the ability to determine impacts of projects and to develop mitigation measures. Pearse's comments provided impetus for the development of this comprehensive fish-habitat data base.

SISS was intended for some very specific uses including:

- initial screening of habitat referrals
- providing an overview of production potential for stock management purposes
- selecting streams for enhancement, restoration or management activities
- identifying streams for research programs
- providing habitat information to agencies, companies and the public

The SISS database proved to be cumbersome since the electronic version was maintained in Vancouver only and proved to be neither user friendly or accessible to regional habitat management staff. Hard copies of the data proved to be more useful than the computer version, and many of the reports that have been produced from the data files can still be found in use in offices across the province.

Because of the difficulties in converting SISS to an updated and better version, a completely new system, or FISS, evolved in the process. The data from this earlier SISS initiative, plus others, have been collated and entered electronically into FISS. The primary difference between SISS and FISS is that the latter is more up to date and can be linked using GIS to a digital map of water courses called the BC Digital Watershed Atlas.

Part of the evolution of these fish-information databases involved the British Columbia Ministry of Environment, Lands and Parks, and the Department of Fisheries and Oceans which developed a watershed atlas that covered all of British Columbia with 1:50,000 digital maps including lakes, streams and wetlands.

The BC Digital Watershed Atlas ultimately had its beginnings in the 1970s and 1980s when the British Columbia Resource Analysis Branch (RAB) devised an hierarchical coding scheme to identify all waterbodies in the province. This system and the data were computerized and digitized. It was in the early 1990s that the agencies pushed forward to the next level by having the data incorporated into a GIS format. From a provincial perspective, the Watershed Atlas was required because of the growing need by a number of resource ministries for the information. This included not only the fisheries agencies but also water and forestry management staff.

In summary, FISS is a geo-referenced database and mapping system of overview fish and fish habitat, and macro-reach and lake classification. The current primary objective of FISS is to assist with four functions including: planning, project reviews, requests for information, and research. FISS consists of fish-information and fish-habitat, macro-reach and lake-classification databases, overlaid on a 1:50,000 digital stream atlas for British Columbia. Specifically this includes:

- fish distribution and abundance, escapements, harvest and use
- resource use, land use, water use and water quality activities
- obstructions, flow, gradient and macro-reaches
- references, abstracts
- value and sensitivity, fisheries potential and constraints, enhancement and management activities and objectives
- life-history timing

For the province, fish habitat data are managed by the Inventory and Data Systems Section of the Ministry of Fisheries. This group:

- coordinates the planning and delivery of fish and habitat information throughout the province
- develops, tests and communicates methods and standards for the collection, storage, analysis, interpretation and reporting of fisheries inventory data
- controls inventory quality
- develops and manages fish and fish habitat computerized data systems, including GIS
- delivers inventory data and products for use by staff, other agencies and the public

For the federal government, fish-habitat data initiatives are managed by the Habitat and Enhancement Branch information management staff.

As part of the efforts in the development of fish habitat information data bases by both levels of government, in 1992 a Resources Inventory Committee (RIC) Aquatic Inventory Task Force was formed by the fisheries agencies to focus on information requirements to define and monitor conservation levels for wild fish populations, and to protect fish habitat in streams, lakes and foreshore environments. For certain initiatives, RIC standards define how fisheries data in the province should be collected. For example, this can provide quality control of fish-habitat data that are to be entered into the FISS system.

Field Inventory Program of Forest Renewal BC

The Field Inventory Program of Forest Renewal BC, formerly known as the Operational Inventory Program,

was initiated in 1995-96 to develop inventories of fish and fish habitat which may be required for the development of wood-harvesting plans as called for under the *Forest Practices Code* (FPC) of *British Columbia Act*. This includes an update of existing information as well as new data. The information involves the inventorying of: fish, fish habitat, terrain stability, water quality and quantity, and traditional use by First Nations. The Resource Inventory Committee (RIC) sets the standards for Reconnaissance (1:20,000) Fish and Fish Habitat Inventory for British Columbia, a specific component of the operational inventory.

The data collected under this initiative are utilized as:

- information for the development of Riparian Management Areas and lake classification under the FPC, which may be suitable for use in operational plans for forest harvesting
- input to the development of fisheries objectives for landscape level biodiversity or the accommodation of identified wildlife or fish in forest development plans
- information that will enable the Ministry of Forests district manager to be satisfied that an operational plan is in accordance with the *Forest Practices Code* of *British Columbia Act* and regulations and will adequately manage and conserve forest resources
- input to overview fish habitat assessment and to Riparian Management Area classification for riparian assessments for watershed restoration

The data collected in the Field Inventory Program are entered into the FISS subject to the requirements that FRBC funding stipulates in the individual contracts for the consultants collecting the information. Non-FRBC funded inventory reports are not automatically entered into FISS but are normally sent to Victoria for data entry by Ministry of Fisheries staff.

Common Land Information Base (CLIB)

The Common Land Information Base is a provincial initiative which provides funds to be used to gather information for pre-treaty and treaty negotiations with First Nations. Because of the importance of fish to the First Nations peoples, inventories of fish and fish habitat are being carried out under this funding envelope. The individual studies take place on a regional basis specific to a particular set of negotiations. These data are not automatically entered into FISS, but are usually sent to Victoria for data entry by Ministry of Fisheries staff as time permits.

Corporate Resources Inventory Initiative (CRII)

The Corporate Resources Inventory Initiative is a provincial program which provides funds to obtain information for sub-regional land use planning throughout the province. The information-gathering exercises include fish and fish habitat inventory and assessment. Land and Resource Management Planning (LRMP) initiatives are the types of exercises to which these data are put to use. Like the CLIB initiative, the CRII reports containing habitat data are not always automatically entered into FISS, and the relevant reports are usually sent to Victoria for data entry by Ministry of Fisheries staff as time permits.

Lower Fraser River Stream Inventory Atlas

The Lower Fraser River Stream Inventory Atlas was developed by the Fraser River Action Plan of the Department of Fisheries and Oceans, in conjunction with the British Columbia Ministry of Environment, Lands and Parks. It was to be used as a primary fish habitat information resource for land and water use planning in the Lower Mainland. The Atlas is a compilation of annotated watercourse maps that can be used by agencies, developers, First Nations, local governments and stakeholders to identify fish habitat areas. As a result of this exercise, there are two different types of map products including a 1:20,000 scale Terrestrial Resource Information Map (TRIM) and a series of 1:50,000 TRIM series overlain on a color orthophoto backing. All watersheds with known fish presence are marked for easy identification for planners and fish-habitat protection managers to use. However, these data are considered to be dated and incomplete for use by local government and development planners.

Sensitive Habitat Inventory and Mapping (SHIM)

Land-use decisions in the rapid-growth urban areas of the lower mainland are being made using base maps that do not accurately display the current location and habitat values of streams, wetlands and the adjacent riparian areas. The Sensitive Habitat Inventory and Mapping (SHIM) program was initiated to fill in some of the data gaps. SHIM can be described as the "next step" of the Lower Fraser River Stream Inventory Atlas described above.

Currently, about 30 percent of small urban streams and watercourses in the Georgia Basin are not properly mapped and the agency inventory data are often older than ten years. In the Georgia Basin it has been estimated that 80 percent of Georgia Straits salmon stocks are dependent on urban streams, thus it is imperative to have good inventory and mapping data in order to protect them. This project will attempt to adopt standardized inventory and mapping, something that has heretofore been missing.

SHIM is an ecosystem-based approach focusing on aquatic habitat and associated riparian areas. It is a multi-year project, started in 1997/98, and is currently active in the Lower Mainland but may be expanded at a later date. To date, SHIM has received its funding from the Habitat Conservation Trust Fund (1997/98 and 1998/99). The project-delivery partners include the British Columbia Ministry of Environment, Lands and Parks, Department of Fisheries and Oceans, Greater Vancouver Regional District, Fraser Valley Regional District, Environment Canada-Canadian Wildlife Service, Langley Environmental Partners Society, Community Fisheries Development Centre and Pacific Streamkeepers Federation.

Although this project is still at the inception stage, there are hopes to achieve a number of deliverables including:

- data are to be collected for multiple end users (i.e., fisheries, wildlife, land-use planning, geomorphology)
- carrying information on data quality and source by individual records
- sensitive habitat designations and data to local government and regional districts

Furthermore, SHIM hopes to deliver the following within the next couple of years:

- expand mapping past initial levels, eventually including other urban and settlement areas in the whole province

- integrate SHIM with Resource Inventory Committee (RIC) standards

Fraser River Estuary Management Plan Mapping

In 1996, Fraser River Estuary Management Plan (FREMP) updated its shoreline classification of the Lower Fraser River, to a very fine scale (1:2,500). These maps provide an inventory the Fraser River estuary resources from the Strait of Georgia upstream to Kanaka Creek and Pitt Lake. These maps are currently used by habitat managers and planners to determine where development may take place in the Fraser River estuary relative to any given or particular ecosystem value. The information was originally in hard copy form but has now been electronically collated and digitized. A computer Geographic Information System (GIS) has been developed for FREMP which provides rapid retrieval of habitat data for managers and habitat protection staff.

Mainstem Fraser River Mapping, Kanaka Creek to Hope

Under the Fraser River Action Plan, an effort was made to quantitatively map fish habitat in the mainstem Fraser River from Kanaka Creek to Hope by the Department of Fisheries and Oceans. Ortho-photography was overlain by habitat polygons for the main river, side channels, and immediately adjacent tributaries in this reach of the river. While still at a draft stage, this work provides an excellent overview of expected habitat values, and now requires ground truthing.

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Municipal Governments

Fish habitat management in British Columbia includes a complex matrix of government legislation, policy and regulation in which the rules are often defined by legal interpretation in the courts. This legislated framework involves various components of the bureaucracy in British Columbia, right down to the municipal level.

The legislation that is specifically designed for the management and protection of salmon and steelhead habitat includes the Canada Fisheries Act. However, there are also recent attempts to develop legislation that allows administrations other than the federal government to protect fish habitat, even though it may not be legislation that is specifically targeted towards fish (e.g., Municipal Act of British Columbia). Furthermore, there is also legislation that is neither specific nor enabling, yet governs a particular set of actions which may have important implications as to how fish habitat may be affected (e.g., Land Title Act).

Legislation normally has policy and regulation attached to it in order to guide those entrusted with ensuring its execution. For example, the 1986 document entitled "The Department of Fisheries and Oceans Policy for the Management of Fish Habitat" guides the direction for the day-to-day delivery of the Fisheries Act in the field, in the management boardrooms, and in the courts. Likewise, the Forest Practices Code of British Columbia Act has a set of regulations that give forest-harvest planners direction in order to protect salmon and steelhead habitat.

Discussed below is the legislation used by the various levels of government that affects the management and protection of salmonid habitat in British Columbia. The roles and responsibilities of these governing bodies will also be outlined with a brief synopsis of the pertinent policy and regulations attached to this legislation. An understanding of this background information is required in order to evaluate the effectiveness of salmon and steelhead habitat management in British Columbia.

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Government of Canada - Federal Government Habitat-Management Structure

Fish habitat management by the federal government is normally undertaken by one of two agencies, either the Department of Fisheries and Oceans (DFO) or the Department of Environment (DOE). The Department of Fisheries and Oceans normally is the lead agency, and DOE concerns itself primarily with issues of water contamination and deleterious substances. The Canadian Coast Guard is sometimes also involved in prosecutions involving habitat (e.g., oil spills from ships) but it has recently been amalgamated with the Department of Fisheries and Oceans and can be considered a single entity.

Within the Department of Fisheries and Oceans there are a number of groups that deal with habitat on a role-and-responsibility basis but the primary group is the Habitat and Enhancement Branch (HEB). HEB is headquartered in Vancouver and also has a number of area offices where regional-program delivery staff are located throughout British Columbia. This includes employees in New Westminster, Nanaimo, Prince George, Kamloops and Prince Rupert. Within HEB are a number of sub-groups which deal with land-use planning, water quality, and habitat conservation. The Community Advisor staff are also linked to HEB with the objective of interfacing the Department of Fisheries and Oceans with public stakeholder groups. Resource restoration staff which deal with habitat issues are also located in headquarters and region.

DFO's Science Branch in Nanaimo also has a habitat group which researches fisheries habitat issues. Finally, the Fisheries Officers of the Operations Branch, Conservation and Protection, are the link between HEB and the courts when Fisheries Act habitat infractions are seen to occur. It is through this branch that investigations are undertaken and charges are laid. As of April, 1999 it is the intention that the management of hatcheries will fall under the aegis of HEB.

Canada Fisheries Act

The Constitution Act of 1867 gave the federal government of Canada the responsibility and authority to

manage and protect fish and fish habitat in inland waters. The extent of federal jurisdiction over fisheries habitat includes: "...the protection and preservation of fisheries as a public resource concerned to monitor or regulate undo or injurious exploitation, regardless of who the owner may be and even in suppression of an owner's right of utilization." The federal Canada Fisheries Act is the legislation that outlines the framework for that protection.

The first version of the Fisheries Act in 1868 had a habitat component which included pollution provisions that were similar to the current Section 36(3) but little else. It was not until 1976 that a component intended to address impacts to habitat became incorporated into the Act; it reads "No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat" (Section 35(1). There are a number of other amendments to the Act which now cover a wide variety of sections relating to specific issues of impact on salmonid habitat (**see Canada Fisheries Act habitat sections in the table below**).

The Canada Fisheries Act has at least three main functions for the protection of fish habitat. First, it is to provide a deterrent to activities which might destroy habitat. Second, it delineates the boundaries with which to penalize those who break the law and, third, it provides environmental guidelines to developers, etc., as to what can be allowed and what cannot be allowed under Canadian law with respect to impacts on fish and fish habitat. These guidelines, if followed, ensure that compliance with the Fisheries Act is occurring with respect to habitat protection requirements.

While individuals have viewed the Fisheries Act as containing "...some of the strongest environmental legislation in the world...," it has certain flaws. Most notably, it tends to be a reactive piece of legislation (e.g., it often comes into play in an after-the-fact fashion once a decision has been made to proceed with an activity that will affect on fish habitat, or after a violation destroying fish habitat has occurred). A planning component, to pro-actively protect these habitats, is not the major focus of the Act. When planning does occur, the agencies must relate the issue to harmful alteration of fish habitat.

Furthermore, the Act does not have the authority to protect landscape ecosystems within a watershed to which the aquatic component is linked. The quality or quantity of the habitat for salmonids may also depend on how the environment outside of the boundaries where the Fisheries Act has normal jurisdiction (i.e., beyond the wetted perimeter, or the riparian area, of a stream or lake) is impacted by human development. Other pieces of legislation such as the British Columbia Fish Protection Act are now being drafted and implemented in order to fill the gaps.

Nevertheless, under the Fisheries Act, defined fish habitat still encompasses a wide variety of environments where fish live. Habitat is defined as the "...spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes..." (Section 34(1)). The legislation also recognizes that fish must be able to travel from one area to another during their lives, so the habitat component of the Act provides for safe fish passage throughout a watershed (Sections 20, 21, 27). Furthermore, free-swimming fish are not the only life-history aspect that must be protected. The Act provides for maintaining minimum flows into a stream "...sufficient for the safety of fish and for the flooding of the spawning grounds to such depth as will...be necessary for the safety of the ova deposited thereon..." (Section 22(3)).

The federal government also realized that fish could be destroyed by the diversion of water for power, agriculture or domestic water supplies. It sought to protect fish from entrainment through water intakes, by requiring screening (Section 30), and from destruction by means other than fishing (Section 32), such as turbine mortality. Also, and mentioned earlier, the habitat component of the Fisheries Act has provisions to protect the quality of the water from human degradation, such as the discard of materials and pollution of fish habitat (Section 36).

Some of the most powerful sections of the Fisheries Act pertain to provisions which deal with the destruction of fish habitat. These include Section 35(1), which states "...[no] person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat." Section 35 is tempered insofar as development can be allowed to proceed, and destroy fish habitat, if the project is considered to be in the best interests of Canadian society. However, an authorization to do so must be made by the Minister of Fisheries or his/her designate under Section 35(2) □"No person contravenes subsection (1) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act." If an authorization to allow the destruction of fish habitat is undertaken, then the Canadian Environmental Assessment Act (CEAA) applies, and as a rule, compensation is required. CEAA is discussed in more detail below.

Where habitat issues are being dealt with in a court of law as a result of charges under the Fisheries Act, the prosecution can proceed by way of summary conviction or by indictment. Most Fisheries Act prosecutions are for destruction of habitat (Sec. 35) or pollution (Sec. 36) (**see table below** for a summary of convictions from 1994/95 to 1996/97). Prosecutions are brought about by activity deemed to impact on fish habitat followed by an investigation. The Crown Counsel or the Crown Attorney, of either the British Columbia Attorney General, or the Attorney General of Canada, decides whether to proceed with a case. This is usually based on evidence provided by the Department of Fisheries and Oceans, Environment Canada, the Canadian Coast Guard or the Ministry of Environment, Lands and Parks.

Charges under the Fisheries Act can also be laid by a private citizen. These proceedings are known as private prosecutions. The Attorney General of British Columbia has the option of assuming the prosecution on behalf of the private individual, or terminating the proceedings by entering a stay. After two successful cases were laid by private initiative in 1980, the B.C. Crown began "taking over" such prosecutions, and often drops the charges. This is now common practice.

The task of giving evidence in environmental prosecutions is deemed to be difficult insofar as it requires the use of science to determine wrongdoing. Environmental science is usually based on probabilities that can be highly subjective. It has been said that "...[t]he evidence presented by the Crown must establish that the offense, as charged in the Information, has been proven beyond a reasonable doubt. This standard of proof is the same as if one was charged with murder." Thus, if the Crown fails to present evidence to meet this burden of proof, or if at the end of the trial the Judge has a reasonable doubt as to whether the charge has been proven, the accused is entitled to an acquittal.

Some significant offenses, and many minor offenses, do not reach the courts, or the violations are ignored by federal Fisheries Officers and the provincial Conservation Officer Service, because of a lack of resources and the time and effort required to obtain a conviction. The alternative to this cumbersome, expensive and

ineffectual method of protecting habitat may be a discretionary ticketing system involving fines that deal with minor offenses yet allow prosecution for large, more serious violations.

The federal Fisheries Act has been challenged in court from a constitutional perspective a number of times, particularly with respect to Section 35 of the Act, which provides for the protection of the physical component of fish habitat, and Section 22, which provides for the protection of flows. Nevertheless, to date, the courts have generally decided that the protection of fish habitat is within the federal government's powers.

Habitat enforcement convictions in British Columbia from 1994/95 to 1996/97 under the *Canada Fisheries Act*

Year	Section 35(1)	Section 36(3)
1994/95	37	25
1995/96	30	4
1996/97	32	17

Habitat components of the *Canada Fisheries Act*

Component	Section
Definitions	2, 34, 40
The Need For Safe Fish Passage	20
Minimum Flow Requirements	21, 22, 66
Recovery of Costs for Obstruction to Fish Passage	20
Protection of Fish in or Near Fish-Ways	27, 29
Requirement for Fish Guards and Screens	30, 69
Destruction of Fish	32
Destruction of Fish Habitat	35, 40
Discard of Miscellaneous Materials	36
Pollution of Fish Habitat	36, 40
Obligations of Proponents	37
Powers of the Minister	37
Offer to Consult and Interim Orders	37

Duty to Report	38
Duty to Prevent or Minimize Damage	38, 40
Power to Make Regulations	34, 37, 43
Designation of Protected Fish Areas	57
Powers of Inspectors	38, 40
Powers of Fishery Officers	49, 50, 52, 56
Seizure of Equipment	51
General Penalties	78, 79
Appeal on Conviction	86
Recovery of Crown Costs	42
Civil Liabilities for Income loss By Fishermen	42
Limitation Period for Laying Charges	82
Applicability to the Crown	3

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Federal Policy for Fish Habitat

The delivery and management and protection of fish habitat in Canada is linked to the Fisheries Act by policy. The current policy objective of "Net Gain of productive capacity [...of fish habitat...] for Canada's fisheries resources" has been in effect since the mid-1980s, with the guiding principle of "No Net Loss" with regard to human impacts resulting from projects or development.

The three main goals of the Policy are:

- maintaining the current productive capacity of fish habitats
- rehabilitating the productivity of fish habitats where there are economic or social benefits
- restoring, creating and improving fish habitats

As part of the Policy, eight strategies have been articulated for its implementation:

- protection and compliance
- integrated resource planning
- scientific research
- public consultation
- public information and education
- cooperative action
- habitat improvement
- habitat monitoring

The overall objective is to achieve "Net Gain in the productive capacity of fish habitat," but because productive capacity is difficult to measure in practice, DFO relies on surrogate measures of physical parameters (e.g., area loss or reduction of a salt marsh or spawning bed).

The policy's genesis lies in part in the 1970s work of the Fraser River Estuary Study, which recognized that a

no net loss policy of protecting fish habitat was required in order to stem the losses that were occurring in these very sensitive and valuable habitats. This discussion carried on right through the 1980s, and in 1986 it was strengthened to a net-gain policy. The Minister's statement at the time was: "...[this] new policy on fish habitat management is an explicit recognition by the federal government that fish habitat is a national asset. It is, I believe, an ambitious but realistic policy designed to achieve a Net Gain of Habitat for Canada's fisheries resources in a manner that will be of benefit to all users. It does this by providing a comprehensive framework for the conservation, restoration and development of fish habitats and strategies for the implementation of its various components."

While the 1986 Policy for the Management of Fish Habitat was a strong move in providing direction to the managers of habitat, it still did not bring a consistent across-the-board application of the Fisheries Act. As a result, the Habitat Conservation and Protection Guidelines were developed in 1994 extending from the Policy for the Management of Fish Habitat (1986). The purpose of this expanded policy was to guide fisheries staff in administering the provisions of the Fisheries Act in the management of fish habitat. Those provisions include the long-term policy objective of obtaining a Net Gain in the productive capacity of fish habitats with the No Net Loss Guiding Principle applied to habitat management decisions. In this document, the important term "productive capacity" is defined as "...the measure of the capability of a habitat to produce fish and/or food organisms in natural or restored conditions. Productive capacity is analogous to carrying capacity which can be defined as the maximum biomass of organisms that can be sustained on a long-term basis by a given habitat."

In dealing with a project in which the existing habitat's productive capacity cannot be maintained as a result of the works, DFO has an hierarchical approach in dealing with the habitat to be impacted. This hierarchy is presented in order:

- relocation -- attempt to move the project of impact away from the habitat area
- redesign -- try to design the project so the areas of impact are as least intrusive as possible
- mitigation -- undertake the project so the damages are neutralized as a result of implementation or construction approaches
- compensation -- this option should only be used when all others cannot be implemented. It is not an option for critical habitats or the release of deleterious substances. Compensation of impacts has a hierarchical option list:

    i. create habitat at or near the development site within the same ecological unit
    ii. create similar habitat in a different ecological unit that supports the same stock or species
    iii. increase the productive capacity of existing habitat at or near the development site and within the same ecological unit
    iv. increase the productive capacity of a different ecological unit that supports the same stock or species
    v. increase the productive capacity of existing habitat for a different stock or a different species of fish either on or off site

- artificial propagation -- this is the least desirable option and will only happen in rare cases

The 1994 habitat policy document also sets out the series of decision steps required by DFO for the

protection of fish habitat as a result of a project application, and these include the following six steps in order:

- review of application from proponent and/or government referral to ensure that all of the required information is included
- project assessment

  Task 1: assess the potential for impacts from project on fisheries and habitat productive capacity

  Task 2: determine level of protection which will be required on the basis of the productive capacity of the habitat, its importance to fisheries resources, and its sensitivity to disturbance

    Class 1 highest level of protection
    Class 2 moderate level of protection
    Class 3 minimum level of protection

  Task 3: assess revised proposal with proposed compensation measures

- conduct public consultation as appropriate
- decide on project authorization
- ensure that compliance monitoring and effectiveness evaluations are undertaken
- enforce the habitat protection provisions of the Fisheries Act

Further to the 1986 and 1994 policy documents, in October of 1998 the policy document entitled "A New Direction for Canada's Pacific Salmon Fisheries" was released by the Department of Fisheries and Oceans. It outlined 12 broad policy principles that are to guide the Department's new approach to the Pacific salmon fisheries. The document signals a shift in focus to a more regional or watershed approach to managing salmon in the province. Seven of the 12 principles are pertinent to salmon and steelhead habitat protection and management:

Conservation

- conservation of Pacific Salmon stocks is the primary objective and will take precedence in managing the resource
- a precautionary approach to fisheries management will continue to be adopted
- continue to work towards a Net Gain in productive capacity for salmon habitat in British Columbia
- an ecological approach will guide fisheries and oceans management in the future

Improved Decision-Making

- clear, objective and relevant information on major issues requiring decisions will be provided to the public with sufficient time and opportunity for review, comment and feedback. Periodic review of

progress and achievements will be initiated to facilitate accountability for the source management of the salmon resource and its habitat

- government and stakeholders will together be responsible and accountable for sustainable fisheries
- enhanced community, regional and sector wide input to decision-making will be pursued through a structured management and advisory board system

Canadian Environmental Assessment Act (CEAA)

The Canadian Environment Assessment Act (CEAA) is designed to ensure that there is a thorough assessment of large-scale projects which may affect the environment and fisheries habitat. However, with respect to fish, small losses of habitat in both small or large projects, which cannot be mitigated against, are still covered under CEAA. Projects requiring federal approval or authorization, occurring on federal land, receiving federal funding, or proposed by a federal department or agency are considered by CEAA. Not all projects that fall under this legislation are subject to a full CEAA. Screening is used to identify which projects require the full-scale review, and small issues are dealt with through an authorization to harmfully alter, disrupt or destroy habitat process subject to compensation.

Environmental Assessment (EA) is considered to be an important tool in ensuring sustainability, and has significant implications with regard to impacts upon fish habitat and development. As a planning tool, EA has been used by Canadian governments since 1974, and was formalized when the Environmental Assessment and Review Process (EARP) guidelines were issued by order in council in 1984. The guidelines provided for integration of environmental factors into the decision-making process for projects involving the federal government.

In 1987, the federal government initiated a public process whereby the EARP would be reformed with the objectives that it would be accountable, administratively simple, based in legislation, effective, efficient, fair and open. The new version of the EA system would also have to be consistent with the EA systems of the provincial governments; it was felt that if there were multiple levels of EA processes, the reviews could unnecessarily bog down a project unfairly.

In 1990, the federal government announced a reform package that included new legislation, a process for new policy and program proposals, and a participant funding program that supports public participation in the EA process. It was believed that by clarifying the rules and boundaries, the new EA process would reduce costs and time demands for all participants.

In June 1992, as a result of the deliberations and legislative initiative, the Canadian Environmental Assessment Act (CEAA) received royal assent and in January, 1995 the Act was proclaimed. The Act sets out in legislation the responsibilities and procedures for an environmental assessment involving the federal government, and purports to establish a clear and balanced process that brings a degree of certainty to the process as well as allowing for early planning and efficiencies.

The CEAA has four stated objectives including:

- to ensure that the environmental effects of projects receive careful consideration before responsible authorities take action

- to encourage that responsible authorities take actions that promote sustainable development thereby achieving or maintaining a healthy environment and a healthy economy
- to ensure that projects to be carried out in Canada or on federal lands do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out
- to ensure that there be an opportunity for public participation in the EA process

In the CEAA process, the projects receive an appropriate degree of environmental assessment commensurate with the scale and complexity of the likely effects of the project. For example there are four types of environmental assessments:

- screening
- comprehensive study
- mediation
- panel review

The first two types of assessments comprise about 99 percent of the federal projects assessed and include the bulk of the fish-habitat related issues. For example, a screening systematically documents the environmental effects of a proposed project and determines the requirement to mitigate the harmful effects, to modify the project, or to recommend further assessment through mediation or a panel review. Small-scale and routine projects are usually assessed through the use of what is called a "class screening," while large-scale and environmentally sensitive projects undergo a more intensive assessment called a "comprehensive study."

Responsible authorities are required to devise a program following the project which verifies the accuracy of the environmental assessment and determines the effectiveness of the mitigation measures. A registry has been established to ensure that access to project-environmental assessment records are available to the public. The Habitat Referral Tracking System (HRTS) is a federal data-base recording system for habitat projects required under the Canadian Environmental Assessment Act (CEAA) legislation. HRTS was implemented in 1994 and has been updated since then. The system is used to track referrals, or information and action on requests, regarding projects which may impact on fish habitat and require a decision under the Canada Fisheries Act. For example, when a development project is undertaken and fish habitat is impacted and compensation is undertaken to ensure no net loss, the impact is recorded and the replacement habitat is entered into the tracking system in order to ensure a record of the actions.

When the CEAA was passed in 1995, HRTS was re-structured so that it could be used to register CEAA-triggered environmental assessments (EA's) on the Federal Environmental Assessment Index (FEAI) and to maintain Public Registries on those assessments. As of 1997 there were almost 300 users of the HRTS system and almost 40,000 records, and for the 1996-97 fiscal year, the Pacific Region has almost 60 percent of the habitat records.

British Columbia has a similar act, the British Columbia Environmental Assessment Act (BCEAA), and both acts have harmonization agreements attached to them to minimize any overlap. If both a CEAA and a BCEAA are triggered, then BCEAA takes precedence with the outstanding issues only addressed by CEAA.

If a project leads to a "harmful alteration, disruption or destruction of fish habitat" (HADD), this triggers the

requirement for an authorization and compensation under Section 35(2) of the Canada Fisheries Act. Following the promulgation of CEAA in 1995 a screening or review would also be required.

A HADD has been described by the Department of Fisheries and Oceans as "...any change in fish habitat that reduces its capacity to support one or more life processes of fish..." Following from this, there is the assumption that the capacity to support life processes is linked to the capacity of the habitat to produce fish. While the Fisheries Act only deals with fish habitat per se, the No Net Loss principle in the Habitat Policy connects fish habitat and productive capacity, which is specifically related to the production of fish.

Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction of Fish Habitat

An authorization is a formal process whereby a proponent is allowed to impact on fish habitat at the discretion of the Minister or the Minister's designated staff. The following outlines the HADD authorization mechanism.

First, a fish habitat manager must decide if an HADD is likely to result from an activity proposed by a proponent. This may first occur when the manager reviews the proposal. This might be followed by a fact finding exercise which may involve field data collection before a decision is made. The decision framework addresses the following questions:

- is fish habitat present at the project site or in an area potentially impacted by the project?

If it is clear that there will be no habitat affected, the matter is then closed and an authorization is not required and the work can proceed.

- could the proposed project cause HADD of fish habitat?

If fish habitat will not be affected by the project in the way that it is proposed, then an authorization is not required. If the proposed project could cause a HADD, then a determination must be made if the impacts can some how be avoided.

- can the impacts to fish habitat be fully mitigated?

Impacts to fish habitat can be mitigated in a variety of ways. Timing windows can be used to ensure that particular life-history stages, such as embryos in the gravel, are avoided during construction. The project may be moved to a location a short distance away or the design may be modified. A Letter of Advice by the Department of Fisheries and Oceans can be used to direct the proponent to methods of avoiding the impact. If mitigation is fully effective and there is no residual impact, then an authorization is not required.

- should the HADD be authorized?

A decision may be made by the habitat manager that a HADD is required in order not to risk a Section 35(1) contravention and as a result impact on habitat. If the impacts are considered to be acceptable, based on a number of criteria, an authorization can be made for the project.

- can the HADD be compensated?

Authorizations are usually not made until compensation has been specified and the details worked out with the proponent.

The Referral Process

Through a system called referrals, the Department of Fisheries and Oceans (Habitat and Enhancement Branch), usually in cooperation with the Ministry of Environment, Lands and Parks (Fish, Wildlife and Habitat Protection Branch; Water Management Branch), addresses senior environmental agency concerns regarding potential impacts to fish and fish habitat. Any type of development which has the opportunity to impact on fish and wildlife habitat is potentially subject to the referral process, including proposed residential, commercial or industrial projects, proposed infrastructure construction or maintenance projects, water licences and instream work applications, proposed municipal land use and density changes (e.g., rezoning applications, subdivision applications, building permit applications, etc.) and higher level plans (i.e., OCP's, growth strategy statements, master drainage plans, etc.).

Referrals are a type of administrative procedure that government agencies can use to serve notice that an application for a project has been made. It can also communicate information regarding a proposed development or activity and determine if the application is at an appropriate level of review. Furthermore, the referral process can be used to exchange information, resolve conflict, coordinate activities, and arrive at decisions.

It should be noted that "referring" an application to other agencies does not necessarily mean the sending of formal documents. It also includes informal discussion of the issue. The number of habitat referrals in the Pacific Region is about 15,000 to 25,000 annually, of which most go to the Department of Fisheries and Oceans, and include everything from telephone calls to detailed major project proposals.

Normally, when a substantive project is about to be undertaken, a synopsis of the development is submitted or "referred" to the senior environmental agencies by the proponents, and the potential impacts are determined by agency staff based on habitat function, productivity, uniqueness and sensitivity. The agencies make recommendations and outline conditions that are required in order to ensure that the legislation, policy and guidelines to the permitting authorities are being adhered to through this system. The proponent may send its application for comments directly to non-permit issuing agencies, without waiting for the granting agency to do so. In this case, the review agency representatives usually send their comments directly to the proponent and copy the approving agency.

Depending on the arrangements, even when applications are received through an approval granting agency, review agency representatives may choose to reply to either the initiating agency or directly to the applicant. Sometimes applications are sent to the other agencies only for their information and no response is expected. Projects are sometimes implemented without the proponent obtaining the approvals using the referral process, and it may be that these projects are being implemented without regard to existing policy and legislative requirements. Consequently, if a violation of a federal or provincial statue occurs, the project proponent could become the subject of formal investigations by the enforcement branches.

In urbanizing areas, the Department of Fisheries and Oceans and the Ministry of Environment, Lands and Parks have streamlined their project-referral system in order to evaluate individual applications for land development and instream works. This evolved in an attempt to provide a consistent, thorough, environmental review for urban development proposals. Nevertheless, for each referral area throughout British Columbia, there have been distinct and endemic processes which have evolved over time. These reflect each region's different characteristics and the approaches of the resource agencies and municipal governments in each region to the areas' resource values and operating procedures. For the most part, the two senior levels of government have jointly developed land-development and stream-stewardship guidelines and have procedures for development in and about streams.

Following from a referral, Fisheries Act authorization under Section 35(2) must be issued if impacts to fish habitat cannot be avoided through mitigation, and this will trigger a review under the Canadian Environmental Assessment Act (CEAA). Regardless of the amount of damage to habitat, an authorization is required if the impacts cannot be circumvented.

A major weakness in the process is that the current legislation does not require that the approval conditions set by senior agencies be included in the final project approval, and there are no established procedures for determining if these approval conditions set by senior agencies are adhered to. Other issues relating to the effectiveness of the referral system are reviewed in the next chapter.

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Government of British Columbia - Provincial Government Habitat Management Structure

The Constitution Act of 1867 gave the provinces the legislative authority over the management of many of the inland resources, the exploitation of which often has the potential to impact on fish and fish habitat. This includes provincial jurisdiction over land, water, forests and minerals, and the management of each of these resources involves their own legislation, policy and regulations. Normally much of this legislation does not specifically take into consideration affects of resource exploitation on fish habitat. Because about 94 percent of British Columbia is Crown Land, and the provincial government directly oversees the management of this land for logging, mining, recreation grazing and other activities, the actions of the province of British Columbia towards this land also has major implications as to how fish habitat on it will be protected.

Despite not having Constitutional authority over fish habitat, British Columbia is still actively involved in the day-to-day management of fish and fish habitat through a variety of venues, including Orders in Council and Memoranda of Understanding, although the ultimate authority still rests with the senior agency.

However, the provincial government has enacted various legislation with fish habitat protection as one goal. For example, the Ministry of Environment Act provides the authority of the Ministry of Environment, Lands and Parks to plan and set standards for, and to manage, protect and conserve all water, land, air, plant life and animal life, with regard to the economic and social benefits they confer on the province. Also, legislated authority to deal with some fish habitat issues is included under the British Columbia Wildlife Act, and responsibilities lie with the Regional Manager of Fish, Wildlife and Habitat Protection Management. Fish are defined as "wildlife" for the provisions of the act that provide for the designation of wildlife management areas and their protection. The Act also provides for the acquisition of land or improvements for the management and protection of fish.

The province has in recent years also introduced additional legislation such as the Forest Practices Code of British Columbia Act and the Fish Protection Act, which tend to deal more with riparian and upslope habitat issues, as well as the allocation-of-water aspects of fish habitat management. These laws, to a certain

degree, are an attempt to fill the gaps in managing fish habitat for those areas that the Canada Fisheries Act cannot cover. To deliver the mandates set out by the various legislation, both levels of government routinely and actively partner in fish habitat management activities.

The roles and responsibilities of managing and protecting habitat by the province are primarily conducted by two bureaucratic groupings □the fisheries program and the habitat protection program □each of which is part of the Ministry of Environment, Lands and Parks. Both provincial fisheries and habitat protection programs have staff who are located in the Regional offices throughout the province, and they are managed under a single umbrella called Fish, Wildlife and Habitat Protection Management. Although the habitat protection program also has a headquarters presence in Victoria, the new British Columbia Ministry of Fisheries, also located in headquarters, is a reconstitution, in part, of the previously headquarters-located Ministry of Environment, Lands and Parks fisheries program. Currently, with respect to habitat, the Ministry of Fisheries is primarily a coordinating and policy body between the regional and headquarters fisheries programs at the executive and political levels. It is possible that all of the fisheries and habitat components of Ministry of Environment, Lands and Parks and the Ministry of Fisheries will be brought under the same umbrella and into their own single entity in the near future.

The regional fisheries programs tend to deal primarily with "one-off" types of habitat issues, such as restoration initiatives and major projects. The regional habitat protection program tends to deal with development planning and routine referrals, both urban and rural development related, and as a result of Crown forest harvest planning. The fish-habitat protection aspects of forest harvest management, as required under the Forest Practices Code of British Columbia Act, are undertaken with the assistance of the Forest Ecosystem Specialists (FES) staff. FES staff routinely interact with Ministry of Forests staff to develop forest harvesting plans as per the Forest Practices Code. They also assist in land management planning, road development, riparian issues, stream and river related activities and other duties. These FES employees normally are not situated within the Regional Offices but are located in the District Forest Offices.

Another new component involving direct involvement of the province in the management of salmon habitat is through the Urban Salmon Habitat Program (USHP) which has technical and management staff in both regions and headquarters working for both fisheries and habitat programs. The USHP, referral process, and Forest Practices Code delivery, will be discussed in more detail below.

The role of the province in protection of both salmon and steelhead habitat has evolved and grown over the last number of decades and particularly within the last five years. While it was natural that British Columbia fisheries biologists and managers would have concerns related to fish habitat issues, and particularly with respect to inland species and steelhead □the species under their jurisdiction □in the early 1970s the British Columbia government recognized the need to expand management of fisheries to the protection of habitats. Since that time habitat management staff have worked from both Victoria and in the regions of the province.

Early on, the Habitat Protection Section was part of the Fish and Wildlife Program, but was made into a separate Branch in 1990 through an amalgamation of habitat protection functions from wildlife, fisheries and other programs. Regional staff have added to the management of fish habitat Forest Ecosystem Specialists (located in the Ministry of Forests District offices) as well as Urban Salmon Habitat Program staff. Issues that the habitat protection staff have routinely worked on include land use planning (regional planning and sub-regional Land and Resource Management Planning), the Protected Areas Strategy, the Forest Practices Code,

the Forest Renewal Plan, Land Management Guidelines, Stream Stewardship Guidelines and Oil and Gas Guidelines, as well as the referral process for development.

The province's habitat protection biologists and technicians often work closely with their counterpart federal fishery habitat staff through the referral process. Large projects, such as the replacement of a hydro-electric generating station, would be dealt with through the British Columbia Environmental Assessment Branch.

In summary, within the provincial government, the delivery of components of the fisheries habitat and water quality protection and restoration by the province takes place, often by arrangements, between and amongst a variety of ministries primarily including the Ministry of Environment, Lands and Parks, the Ministry of Fisheries, Forest Renewal BC through the Watershed Restoration Program, and the Fish Renewal BC Corporation. The province's role in protection of fish habitat also includes:

- reviewing development proposals (Planning and Assessment Branch; Fish, Wildlife and Habitat Protection Management) and major projects (Environmental Assessment Branch; Fish, Wildlife, and Habitat Protection Management)
- developing forest harvesting plans (Forest Ecosystem Specialists), involving itself in habitat restorations projects (Forest Renewal BC Watershed Restoration Program; Habitat Conservation Trust Fund; Fish, Wildlife and Habitat Protection Management)
- water quality control (Pollution Prevention Branch)
- assisting Department of Fisheries and Oceans in developing guidelines (Ministry of Environment, Lands and Parks, Ministry of Fisheries)
- undertaking research (Ministry of Fisheries, Fisheries Research Section)
- prosecuting violators under the BC Wildlife Act and the Forest Practices Code, as well as the Canada Fisheries Act (Ministry of Environment, Lands and Parks Conservation Officer Service)

Policy

Both the province's habitat protection program and the fisheries program have developed policy documents which guide and direct their respective program deliveries. The goals of the habitat protection program are to:

- maintain the diversity of habitats and ecosystems
- maintain threatened and endangered habitats, and the habitats of rare and endangered species
- advocate resource management alternatives that favour ecological integrity
- support, enhance and share an ecological knowledge base
- promote the understanding of ecological principles through communication and education

The provincial fisheries program goals are more specifically directed at fish and embody the management of fish habitat from a British Columbia perspective, including "...to conserve the natural diversity of fish and fish habitat...in British Columbia." Fisheries management is defined by the fisheries program as "...the process of sustaining, using and understanding fish and fish habitat through inventory, research, regulation, allocation, enhancement, protection and enforcement."

Finally, the Program is guided by a number of stated principles including:

- The Precautionary Principle: The Program has also accepted the "precautionary principle" adopted in the 1992 United Nations Conference on the Environment and Development Declaration which "...means we have a responsibility to take precautionary measures to anticipate, prevent or minimize adverse effects to the environment. The lack of full scientific certainty as to impacts is not adequate reason to postpone measures that will protect the resource. We also seek to improve our scientific and technical knowledge of aquatic biodiversity and fisheries."
- Conservation: "Our first priority is conserving wild fish and their habitat including wetlands and riparian areas, and ultimately the conservation and maintenance of genetic and ecosystem biodiversity. The Fisheries Program definition of conservation is: the protection, maintenance and rehabilitation of native fish and their habitat to ensure ecosystem sustainability and biodiversity."

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Municipal Governments

Urban development is responsible for some of the most serious impacts to many of our most highly productive small watersheds containing salmon in the Lower Mainland and southern Vancouver Island, an area often referred to as the Canadian portion of the Georgia Basin. This region's current population of over 2.6 million people is expected to double in the next twenty years. This may lead to ongoing habitat losses unless a strong measure of fish-habitat protection is achieved through local governments' growth management programs. These programs, which involve planning, development approval and servicing, will be the primary key to protecting fish-habitat ecosystems in these geographic areas, often irrespective of federal and provincial resource management prerogatives.

The sections immediately below will highlight how local governments can use their powers to address the protection, restoration, enhancement and maintenance of salmon and steelhead habitat.

Local Governments in British Columbia

Land use and local governmental affairs are provincial jurisdictions in Canada. British Columbia, through its Municipal Act, establishes local authorities (generically called "local governments") including regional districts, municipalities (district and resort), cities, towns and villages and the Islands Trust, for the purposes of providing services to their respective communities. Among other things, these services include the development and implementation of regional growth strategies, community planning, zoning and development control. All local governments, except the City of Vancouver (which has its own Charter), operate under the Municipal Act with respect to these roles and some, like the Islands Trust and the Resort Municipality of Whistler, have additional powers under their Acts.

In effect, these powers are virtually autonomous with respect to urban development, although they are limited or overridden regarding the use and development of agricultural and forest land and minerals (including aggregates). The Agricultural Land Reserve Act, Forest Land Reserve Act, and the Farm Practices

(Right to Farm) Act, the Highway Act and some Crown Corporation legislation, are examples of overriding legislation affecting local government jurisdictions.

Local government authority, unless overridden, applies to all private land as well as private uses of Crown land. Furthermore, the definition of land in the Municipal Act includes the surface of water □both marine and freshwater. Typically a local government boundary extends to the middle of a water body where it meets an adjoining local government boundary. Local governments can regulate (and prohibit) such water surface-uses as docks and aquaculture operations in areas under their jurisdiction.

Local governments, with the exception of the Islands Trust, have authority for the provision of water services. However, in these cases standards respecting water quality may be set by the province under the Waste Management Act and the Health Act; how and where a local government obtains its water for consumption can have significant impacts on salmon and steelhead habitat. The Waste Management also enables the Province to require local governments to prepare waste management plans. Liquid waste management plans must address both sewage and storm water, and these are also important components potentially affecting fish and fish habitat.

Finally, under the Land Title Act, the opportunities to protect fish habitat in areas under local government jurisdiction include the implementation of subdivision-design conditions and (protective or conservation) covenants. Subdivision approval is administered under the Land Title Act (for freehold subdivision) and the Condominium Act (for shared land and building ownership). An approving officer, appointed under the Land Title Act, considers matters of "public interest" which can be beyond those specified in a bylaw or permit requirement. In determining the public interest, an approving officer can require environmental information for subdivision approval, including fish habitat.

The British Columbia Fish Protection Act and New Local Government Powers

In 1997 British Columbia passed a new Fish Protection Act which will be giving local governments the opportunity for a comprehensive set of fish-habitat protection powers. This new legislation is an attempt to address concerns about the ineffectiveness of federal and provincial legislation to protect fish habitat from the cumulative effects of urban development. It also attempts to address the reluctance of many local governments to use their existing powers to deal with the loss of fish habitat in their areas.

The Fish Protection Act gives Cabinet the power to enact particular powers with respect to protecting fish habitat including "Streamside Protection Policy Directives" (SPPDs). SPPDs may require local governments to protect riparian areas in association with residential, commercial and industrial development. SPPDs are intended to be similar in effect to existing provincial overrides with respect to the use and development of agriculture and forest lands, although they will be different in form.

At present, SPPDs are being developed in consultation with local governments, fishery agencies, non-government organizations, the development industry and the interested public. It is anticipated that these will come into force in early 2000.

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It is unlikely that the magnitude of salmon and steelhead habitat losses that have occurred in British Columbia since the arrival of Europeans will ever be known. This is due, in part, to the fact that we still do not fully understand what constitutes fish habitat in our streams, lakes and wetlands, and also because memories of what the landscape and streams looked like have diminished with time. Nevertheless, there have been some attempts at assessing what habitat actually does remain compared to what was available in the past.

Some impacts upon habitat are easy to estimate, such as a where a dam blocked a stream and impeded passage of fish upstream. Other effects are more difficult to quantify, such as the incremental habitat losses occurring over a long period of time as a result of urbanization.

Recent innovations in mapping, flow modeling and forensic research, such as analysis of core samples from lake bottoms and rare-isotope analysis, have helped make the undertaking of estimating historic habitat losses easier. The following is a short summary of attempts to estimate losses. It also reviews how agencies are dealing with current and continuing habitat declines.

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Wild, Threatened, Endangered and Lost Streams of the Lower Fraser Valley

In 1997 the Department of Fisheries and Oceans (Fraser River Action Plan) published a summary report looking at impacts to streams in the Lower Fraser Valley that were historically used for spawning and rearing of salmon and steelhead. The overview began by looking for streams on the original maps of the study area from the 1860s, and comparing these to today's maps, in order to determine streams that have been lost as a result of human activities. Extant streams were also categorized as endangered, threatened or wild, and a major exercise involving agencies, consultants and community groups was undertaken in order to obtain an estimate of the current level of impact by humans for the remaining habitat.

Specific criteria were involved in the decision-making process as to how the stream was to be categorized. These review criteria included whether there was:

- significant loss of riparian vegetation along more than 50 percent of the fish-frequented length of the stream
- channelization, armounization, or diking of over 50 percent of the fish-frequented length of the stream
- effective impermeable area (EIA) covering approximately ten percent or greater of the watershed<

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- greater than 50 percent diversion of stream flow or significant manipulation of flow
- significant water quality problems, i.e., temperature, water chemistry (including urban impacts; not including impacts from logging)
- logging that had been extensive in the watershed, and impacts (direct or related) have been obvious
- urbanization — settlement in the watershed had significantly altered the stream basin
- other impacts (i.e., agricultural/urban impacts, anthropogenic barriers, and cumulative effects of these impacts)

For the analysis, the occurrence of one impact criteria meant the stream was threatened, two or more classed the stream as endangered and the occurrence of no impact criteria for a watershed meant that it was classed as wild.

The study found that of 779 steams from Hope to the Strait of Georgia, 117, or a full 15 percent, were considered to have been lost as a result of culverting, paving, draining or filling over. Furthermore, another 375 (48 percent) were classed as endangered, 181 (23 percent) ranked as threatened, and only 106 or 16 percent of the streams were considered to be wild. The development footprint that had severely impacted on these watersheds included forest harvesting, agriculture, industry and urbanization, with each potentially causing major impacts an any particular stream.

While this study is not considered by its own authors to be complete, it is comprehensive enough to demonstrate the high level of impact to the resource through man's activities to these streams in the lower mainland. Presumably, an exercise such as this would show similar impacts and losses if undertaken for the whole of the Georgia Basin/Southern Vancouver Island areas. The fundamental conclusion of the study is that small, highly productive salmon streams in the Lower Fraser Valley had been impacted at an alarming rate and continue to be so affected.

Impacts to Urban Streams Resulting from Storm Drains

In a non-disturbed environment, when rainwater enters the landscape it runs off the land as surface water or else seeps into the soils and becomes groundwater; alternatively it leaves the land through evapo-transpiration. On its way downstream, or into the soil, water normally will pick up soluble and sometimes non-soluble materials. If these materials are human-deposited pollutants, there is the opportunity that they will end up in a stream, river or lake or an underground aquifer. This phenomenon happens regularly in urban and agricultural situations and because the origin of the pollutants are often so diffuse (e.g., fertilizers, lawn clippings, pesticides, fuel and oil drippings, antifreeze, cow and chicken manure), they are referred to as non-point sources. In urban environments these contaminants often enter the storm-drain sewer and hence into a fish-bearing stream.

While instream and riparian salmonid habitat can often be reasonably well protected through legislation and land development guidelines, there is a growing realization that the changes of flow patterns to streams as a result of storm-water run-off, and drainage changes arising from urbanization, can have an immense impact on fish ecosystems. To begin with, the simple clearing of forested watersheds causes significant changes to the flow patterns. A 25 percent patch clearcutting in conjunction with road development induces a 50 percent increase in the magnitude of all runoff events in watersheds less than 100 hectares in size.

The further development of the landscape into an urban environment then leads to the creation of effective impervious areas (EIA's) which is that part of the landscape where water does not infiltrate into the soil and is then connected directly to a drainage network. Parking lots, roads, building roofs, and sidewalks all contribute to an impervious surface. After a ten percent effective impervious area occurs in a subdivision development, stream flow patterns start to become unstable and stream degradation occurs dramatically after 10-15 percent; some of British Columbia's urban areas have EIA's which greatly exceed 30 percent.

In the 1990s drainage engineers researching the issue of the effects of EIA's in the Puget Sound area began to correlate the cumulative impacts of changed stormwater flows with destruction of salmonid habitat. With this realization began a movement by planners to incorporate more ecosystem-sensitive approaches to maintain run-off distributions that could still provide some fishery protection. The *Municipal Act* Section 966 gives local government the authority to regulate stormwater disposal and begin to address this serious issue affecting salmon and steelhead habitat.

Fraser River Estuary

The Fraser River estuary is one of the most biologically productive habitats in British Columbia. Prior to the substantial European influence on the habitat and the Hell's Gate rock slide in 1914, historical records suggest that the harvest of salmon for the Fraser River was about 30 million. This number is now routinely less than ten million fish and much of the historical production is thought to have arisen from a much greater habitat capability.

Approximately 70 percent of the estuary's original tidal lands have been altered as a result of diking, dredging, draining and filling. 50 percent of the actual habitat has been lost since 1880. The federal, provincial and local governments undertook a study of the Fraser River Estuary in the 1970s and estimated the losses specific to habitat-type.

Change in surface area (ha) of lower Fraser River wetlands, by habitat type, from pre-European to 1978

	Historic	1978
salt marsh	2,230	380
bullrush marsh	1,760	1,690
cattail/sedge marsh	1,830	1,493
wet meadows	12,400	2,604
wet meadow/willow	2,350	258

With a stronger emphasis on the protection of fish and wildlife values by governments and public interest groups, the Fraser River Estuary Management Plan (FREMP) was put together to help coordinate governments in stemming some of these losses. The FREMP has also had an accounting of the habitat losses

and gains and are tabulated below for the years from 1986 to 1997. FREMP suggests that there has been a modest gain overall in habitat during that period. The table below provides these numbers but does not include an important FREMP log-storage initiative whereby log-booms were moved off of 300,000m^2 of sensitive intertidal areas, where they were damaging the habitat by the grounding of the booms during low tides, and on to mid-water areas. Note also that sub-tidal dredging impacts on fish habitat are not included in this accounting.

FREMP assessment of habitat losses and gains in the Fraser River estuary from 1986 to 1997, stratified by type, in square meters	
subtidal	-30,150
unvegetated intertidal mudflats	-80,395
eelgrass beds	+28,000
subtidal/intertidal rock	+15,545
intertidal channel	+2,000
marsh	+113,288
riparian	+29,580

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American Fisheries Society Stock-Status Study

The American Fisheries Society commissioned an independent scientific review of the status of anadromous salmon and steelhead in BC and the Yukon and, while not strictly an habitat study, gave a very clear insight as to the historical effects of habitat degradation in this province. Of the identified 9,662 populations of salmon and steelhead, this work indicated 624 stocks were at high risk, 78 were at moderate risk, 230 were of special concern, and 142 stocks had been extirpated in this century. Furthermore, a large amount of information is still unavailable as 43 percent of the stocks could not be classified due to an absence of reliable data.

It was the opinion of the study that the stock extirpations that they had accounted for had occurred as a result of impacts to habitat. Specifically, logging, hydropower and urbanization were responsible for most of the 142 documented salmon and steelhead extinctions, with hydro-power and urbanization accounting for the greatest number. Furthermore, this study is now considered to be "dated" with the opinion that substantially more populations of salmon and steelhead are now falling in the category of At-Risk.

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Salmon and steelhead stocks at risk in British Columbia					
	Unthreatened	Unknown	At-Risk	Extinct	At Risk/Extinct

chinook	330	459	60	17	9%
sockeye	463	370	64	20	9%
pink	1298	679	175	17	9%
chum	966	473	164	22	11%
coho	1024	1284	257	29	11%
steelhead	282	415	161	9	22%

Adapted from "Living Blueprint for BC Salmon Habitat" 1998 and "Status of Anadromous Salmon and Trout in British Columbia and Yukon" by T.L. Slaney, K.D. Hyatt, T.G. Northcote, and R.J. Fielden.

The 1997 Report of the Auditor General Chapter 28 — Pacific Salmon: Sustainability of the Resource Base

In 1997, the Auditor General of Canada undertook an audit of how the Department of Fisheries and Oceans was managing habitat. He concluded that the habitat base for Pacific salmon was eroding but the full extent of threats and damage was not known. The audit also indicated that 20 to 30 percent of the small stocks in British Columbia that had disappeared were due to habitat perturbations. The Auditor noted that a previous Department of Fisheries and Oceans' Internal Audit in 1993-94 indicated that nationally it spent about 20 percent of its budget on "Net Gain" while the remaining 80 percent was on "No Net Loss"; in the Pacific Region the allocation was about 50/50. The 1997 Auditor's report indicated that sustainability of salmon required protection of the habitat of both large and weak stocks in order to preserve the genetic integrity required under changing environmental conditions, including global climate change.

It was the view of the Auditor General that the 1986 habitat policy established a proactive framework for the management of fish habitat of which the referral process was a contributing component, but that this changed with the new Habitat Conservation and Protection Guidelines in 1994. The report indicated that the new perspective on habitat changed its focus from planning to a more reactive approach. This was viewed as a concern.

The auditor also felt that the level of monitoring, both during the work and afterwards, was lacking. This includes monitoring during the project as well as a follow-up afterwards to determine if the mitigation or compensation measures worked.

The increased use of partnerships to protect habitat was also recommended in the audit. The amalgamation of the Salmonid Enhancement Program and the Habitat Management Programs to create the Habitat and Enhancement Branch was considered to be a good move. There was a need to have good communication and cooperation between fisheries management and habitat management, between habitat management and habitat science, and between habitat management and habitat enforcement.

A summary of the recommendations by the Auditor General of Canada included:

- the Department of Fisheries and Oceans should give the collection and management of information

on Pacific salmon stocks and habitat a high priority to meet both the needs of the resource managers in the field and any reporting requirements on the status of the resource

- the Department of Fisheries and Oceans should clarify the extent to which it intends to apply sustainability and genetic diversity practices to the management of individual salmon stocks and their habitats
- the Department of Fisheries and Oceans should develop more explicit operational objectives and targets to address sustainability and genetic diversity of salmon stocks for inclusion in fishing plans
- the linkage between harvest management and fish production, including enhancement as well as habitat protection, needs to be strengthened
- the Department of Fisheries and Oceans should increase its level of participation in regional and community-based planning initiatives
- the Department of Fisheries and Oceans should work with the province of British Columbia to improve efficiencies in the referral system, subject to an appropriate accountability framework being put in place to satisfy the Department's national mandate for habitat protection
- in implementing the referral process, the Department of Fisheries and Oceans should devote more time and effort to compliance monitoring and follow-up in order to assess the effects of its habitat management decisions and its performance toward the achievement of "No Net Loss" of habitat
- the Department of Fisheries and Oceans should review the performance of existing cooperative arrangements in British Columbia and build on those models that have produced positive results in habitat conservation
- agreements setting up such cooperative arrangements should contain a statement of objectives, a clear definition of roles and responsibilities, expected results and requirements for program coordination, performance reporting and evaluation
- the Department of Fisheries and Oceans should review the effectiveness of its Habitat Policy and habitat management program and develop a strategic approach to guide its negotiation of a new sub-agreement on habitat conservation and protection with British Columbia

Historic Losses of Fish Habitat in British Columbia Due to Logging

There has not been a comprehensive document on the losses of fish habitat by logging in British Columbia due to the time frame — over one hundred years — and the extensive geographic magnitude of the impacts. However, it is implicitly assumed from the extrapolations of recent forest practices that the sum of this must be substantial. We do know that at least 40 percent of provincial forests have been logged without adequate controls on impacts to fish habitat since the mid-1800s. Nevertheless, in recent years, there have been some attempts at quantifying specific quantum of impacts under particular logging practices, or extent of impacts in geographic areas of particular concern.

The first major study investigating forest impacts on salmonid habitat in British Columbia took place over a 25-year period on the Carnation Creek watershed on the west coast of Vancouver Island starting from about 1970. It is currently the longest-running program dealing with the impacts of forestry practices on a coastal stream ecosystem in western North America. A second initiative in British Columbia was the Fish/Forestry Interaction Program (FFIP) conducted on the Queen Charlotte Islands which began in 1981. The FFIP focused on the effects of landslides on channel morphology and fish habitat, and rehabilitation techniques and

silviculture treatments. These studies showed that the existing forest practices were damaging to fish habitat throughout coastal British Columbia salmon and steelhead watersheds.

In many ways, these studies led to the development of the Coastal Fisheries Forestry Guidelines, released in 1988, which provided the basis for the protection of salmon bearing streams along the coast of British Columbia. These guidelines did not apply to logging in the interior of the province. However, there was growing concern that the Coastal Fisheries Forestry Guidelines were not being adhered to and the protection of fish habitat was failing in many instances. As a result, the Tripp Report, released in 1994, and entitled "The Use and Effectiveness of the Coastal Fisheries Forestry Guidelines in Selected Forest Districts of Coastal British Columbia," as well as two other companion reports in 1992 and 1995, brought the issue of non-compliance by these guidelines into the public spotlight. These studies showed that significant impacts were occurring on fish-bearing streams as a result of logging practices in coastal British Columbia due to the lack of compliance with the Guidelines.

Subsequent to the Tripp Reports, the *Forest Practices Code* of *British Columbia Act* was put into place in order to manage these industrial impacts on fish habitat. On December&nbps;15, 1995 full compliance with the Code was required for cutblock-specific silviculture prescriptions. However, after the Forest Practices legislation and some of the regulations were put into place, certain advocay groups felt that the new rules were still not protecting fish habitat as biologically required.

In February 1997 the Sierra Legal Defense Fund released an audit of the application by the government and industry of the *Forest Practices Code* to riparian and instream management practices in British Columbia. The audit report was entitled "Stream Protection Under the Code: The Destruction Continues" which severely criticized the effectiveness of the Code in protecting fish habitat during forest operations. For the four coastal Ministry of Forests districts which were examined, the report suggested that:

Planning Approval Audit

- 83 percent of all streams were clearcut to the banks including 2.5 percent which were modified clearcuts where some brush was left
- for the most part, the harvesting was approved by the Ministry of Forests
- in the discretionary "Management Zone," only three percent had a no-harvest designation
- only 12 percent of the streams prohibited yarding across the streams; for the rest it was discretionary or permitted explicitly
- even the known very small fish streams with only Management Zones were clearcut 79 percent of the time
- 44 percent of all stream reach plans did not contain the minimum information required by the Code

Field Review Audit

- 89 percent of the field-checked cutblocks had non-identified or miss-classified streams
- 40 percent of all streams checked in the field were either non-identified or misclassified
- 11 percent of all streams were not identified or disclosed by the logging company
- 82 percent of the streams checked in the field were felled and yarded across
- less than half the streams on the cutblocks (43 percent) which should have been classified as a fish

stream under the Code were properly classified as fish streams
- of the remaining streams which were identified as fish-streams in the plans, over half were given an improperly low classification

In order to determine if the Sierra Legal Defense Fund's study had any legitimacy, the Forest Practices Board of British Columbia undertook its own special investigation of the effectiveness of the *Forest Practices Code*. Streams in a total of 96 cutblocks were chosen out of 430 that had been harvested since the Code was put into effect. The study sample included six Ministry of Forest coastal districts, in order to cover a broad geographic range and large enough sample size in order to have validity, according to the study report. The two primary objectives of this study were to determine if the streams had been properly classified during the planning phase and whether the rules had been followed once the loggers began to harvest in the forest.

The positive conclusions that the Board came up with included:

- the level of disturbance to streams is now significantly lower than in the pre-Code period
- larger streams with fish are now adequately protected by mandatory riparian reserve zones
- compliance with plans for reserves has increased
- more emphasis is being placed on falling and yarding away from streams and clearing logging debris
- detailed planning requirements have increased logging crew's awareness
- larger streams are tending to be excluded from harvest areas during the design stage

The negative conclusions that the Board came up with were as follows:

- while the operators tended to meet the requirements of the code, the classification of streams was often at fault. In particular were those smaller streams which were on the borderline of being fish streams versus non-fish bearing
- the primary causes of misclassification were stream recognition and measurement error
- the lack of inadequate fish inventory information and associated compliance errors added to misclassification
- there were problems with stream cleaning and falling and yarding away from streams, as required by the plans
- the investigation measured consistency with recommended practices in the Riparian Management Guidebook and found room for improvement

The recommendations that the Board made include:

- develop objectives for wildlife habitat and biodiversity
- improve forest practices near small streams
- monitor streams over a long period

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The Ward Report — Water Diversions and Storage at Ten Sites: Review of Licenced Operations

While not specifically a fisheries audit, the Ward Report reviewed the compliance of BC Hydro with respect to their hydro-electric power generation Water Licences on watersheds with high fisheries values. For the 14 licence groups examined, five projects (36 percent) diverted more water than permitted by licence while for four other projects the amount was not known relative to required maximum explicitly directed by licence. That is, unrecorded water, potentially available for fish was being used by the Crown Corporation for the production of power.

In another related audit also by Ward and Associates, an issue of non-compliance was found to occur on the Cheakamus River. The Cheakamus River was dammed in the late 1950s and subsequent to the impoundment, many of the salmon populations crashed in this watershed. The audit showed that BC Hydro had been violating conditions with respect the Cheakamus Generating Station Water Licences, particularly in regard to the amount permitted to be diverted in a year.

The agencies felt that the change in the river hydrograph as a result of power generation system operations had much to do with the demise of the fish populations in the Cheakamus River. While the cause-and-effect factor(s) causing the decline of these fish populations was never clearly determined, it was felt by the agencies, and by BC Hydro, that the diversion of the water had been a contributing component.

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Subsequent to the tabling of the Ward Reports, both BC Hydro and the province realized that there was a requirement to address outstanding fisheries issues on licenced hydro-electric projects with historic fish values. Simultaneously, in November, 1996 the government announced that it was undertaking Water Use Planning for all Hydro Water Licences. BC Hydro, the Department of Fisheries and Oceans, Ministry of Fisheries, Ministry of Environment, Lands and Parks, and the Ministry of Employment and Investment are starting to initiate Water Use Planning in conjunction with various stakeholders including local governments, fisheries interests, First Nations and others. The Cheakamus River is high on the priority list.

While the agencies and BC Hydro are waiting to initiate a WUP for the Cheakamus River, has in conjunction with DFO, MELP, the Steelhead Society of BC, and Squamish First Nations, developed an interim instream flow release. BC Hydro has also developed interim flows for a variety of other watersheds in the Bridge River/Coastal hydro-electric generating area including Alouette River, Stave River, Coquitlam River, Bridge River, Campbell River and others, with anticipation that once the Water Use Plans are developed for these streams the optimal balance of flows for fish and power will be achieved. A Water Use Plan has been developed for Alouette Generating Station and the Campbell River and Stave River licences are currently being reviewed through the planning process.

Water Use Planning is discussed in more detail in the next chapter.

The Urban Referral Evaluation — An Assessment of the Effectiveness of the Referral Process for Protecting Fish Habitat (1985-1995)

In March, 1997 a compliance audit of the referral process used by the fisheries agencies, for the protection of fish habitat for development in urban environments, was released to the public. Referrals are inquiries to the federal or provincial government habitat protection staff from a proponent who may be impacting on fish habitat as a result of some activity. Referrals may include everything from telephone calls to major-project proposals.

A variety of arrangements have been made throughout British Columbia to deal with the referrals, with the province and the federal agencies dividing up these as outlined by formal and informal agreements. The two governments have jointly developed land development and stream stewardship guidelines and have procedures for development in and about streams. The referral process and its ties to legislation is discussed in much more detail in the previous chapter.

The audit looked at five small watersheds across the province where extensive urban development had occurred over the preceding decade, including Vancouver Island, the Lower Mainland and the Okanagan. Much of the direction by the habitat protection staff to the developers had been recorded so it was possible to attempt to determine the amount of compliance.

Overall project compliance for development on five watersheds, 1985-1995			
	Minor Non-	**Significant Non-**	**Not**

Compliance	Compliance	Compliance	Determined
28%	14%	42%	15%

The results of this study showed that non-compliance by the developers, with respect to the project-approval conditions as required by senior fisheries agencies, was significant for all the watersheds studied. An extension to this report concluded that while the urban approval system appears to have slowed the rate of degradation of fish habitat and water quality in each of the study watersheds, it has not prevented the degradation of these features.

Despite its flaws, the report also concluded that the existing urban referral system has several strengths. First, it provides a mechanism for regulatory agencies to comment on proposed projects that may have impacts on fish or fish habitat. The referral system also provides opportunities for the agencies to address issues that are not covered by existing guidelines, standards and regulations. In those regions where there is a referral coordinator, the referral process coordinates agency responses and reduces duplication of government effort.

The referral process also strengthens the relationship between the three levels of government, federal, provincial and municipal. In some cases this has evolved into the organizations working together and developing formal and informal arrangements to further simplify the referral task. The report suggests that most of the observed weaknesses in the referral process result from differences in the operating and administrative approaches between the various regions, the level and nature of monitoring and enforcement activities undertaken by the agencies, and differences in the technical or biological requirements of approval conditions between the regions.

The report on the referral process also made a series of recommendations based on its findings. They are as follows:

- senior agencies should develop a standard referral framework which is broad in scope and addresses the range of potential impacts associated with the type of proposed development and has explicit, rigorous and specific conditions. The specific requirements of the *Land Development Guidelines for the Protection of Aquatic Habitat* should form the basis of approvals, as they are intended to preserve fish habitat and water quality
- senior agencies should explore the feasibility of revising the *Land Development Guidelines* to address redevelopment projects and convert some elements of the *Land Development Guidelines* into regulations
- the use of independent environmental monitors should be continued in the Lower Mainland Region and promoted in the other administrative regions of the province
- performance bonds and/or irrevocable letters of credit should be required for projects which require habitat compensation
- habitat alteration and destruction offenses should be given a higher priority by the Conservation Officer Service and Fishery Officer Service of the Department of Fisheries and Oceans. Furthermore, within each region enforcement and habitat staff of the Department of Fisheries and Oceans and the Ministry of Environment, Lands and Parks should develop a response procedure and habitat enforcement agreement

- detailed stormwater management plans should be required for the construction phases of larger developments or other developments which have a high potential construction phase impacts to fish habitat or water quality
- the current referral process does not permit reviewers to address the cumulative environmental impacts of development. Senior agencies should explore mechanisms for their inclusion, primarily at the higher level planning stages (e.g., growth management strategies, OCP's, master drainage plans, etc.)
- there should be a continued emphasis on education and awareness

The audit also made comments regarding the roles of the municipalities. Although the *Municipal Act* does not require that the municipalities protect aquatic habitat, municipalities are the land managers and provincial legislation gives them certain powers that may be used to protect the natural environment. (e.g., *Local Government Statutes Amendment Act;* see above in previous chapter). With respect to municipalities, the report also recommends:

- given the critical importance of higher level municipal plans in the protection of fish habitat and water quality, the senior fisheries agencies and the Ministry of Municipal Affairs should designate Official Community Plan (OCP) specialists. These individuals should promote aquatic habitat protection and provide assistance to regional and municipal government staff during OCP reviews and other higher planning initiatives
- tools that municipalities can use to proactively address fish habitat concerns and to contribute to making the referral process more effective include: inventories of fisheries sensitive areas (and their corresponding maps) best management practices guides, and operational standards. These products can form the basis for Development Permit Areas and associated guidelines, and can be used at the strategic level (when developing land use policies and zoning bylaws) as well as the current planning level when development occurs
- haring of inventories, maps and research findings between agencies and municipalities can lead to better coordination in managing environmentally sensitive areas, including fish habitat

No Net Loss of Habitat: Assessing Achievement Workshop 1997

The Assessing Achievement Workshop of No Net Loss of Habitat was held in 1997 at Kwantlen University College in Richmond. It was a gathering of habitat fisheries professionals from both federal and provincial governments, as well consultants, and it was aimed at determining whether the "No Net Loss" principle of the 1986 national Habitat Policy was delivering what it was intended to.

The Workshop was structured in a manner in order to encourage information exchange and answer the two questions:

- what has been achieved in terms of the conservation goals of the No Net Loss Policy?
- are the concepts of mitigation and compensation being met in practice?

The workshop covered four major areas of habitat impact including major linear projects (e.g., pipelines,

railways, highways), major site-specific projects (e.g., port development), urban development, and rural setting (agriculture and forestry). The key issues, conclusions and summary of the workshop are as follows:

Key Issues

- consistency — there is a distinct lack of consistency with how No Net Loss is applied within regions, amongst regions, amongst different types of habitat destruction, between habitat types
- watershed approach — cumulative and non-point impacts to fish habitat are often destroying watersheds because the whole ecosystem and landscape is not being considered
- information — the data and science required to ensure that No Net Loss occurs are usually lacking
- egislation/process — the existing federal legislation is not sufficient and it is not being used to its full potential. Other jurisdictions (i.e., provincial) must be brought further into the picture
- resources — the current levels of funding and staffing are not sufficient to achieve No Net Loss
- accountability — a lack of accountability on many sides is occurring with respect to habitat
- achieving No Net Loss — there are complicating factors in attempting to deal with how much to provide to obtain no loss and the failure risk associated with re-establishing habitat

Conclusions

- major linear projects — No Net Loss is not being achieved; much of the impacts are related to non-point source impacts and lack of addressing cumulative impacts
- major site-specific projects — of the four impact scenarios, habitat losses from large site-specific projects is probably least due to the money available to address the impacts and the usually contained nature of the impacts
- urban development — No Net Loss is not occurring and this has been backed up by a recent major audit of the referral system (see above)
- rural setting (agriculture and forestry) — watershed area planning approaches have to be taken if No Net Loss is to occur and it currently is not

Recommendations

- consistency — is required and can be better achieved by bringing various groups together (i.e., headquarters and regional)
- watershed approach and cumulative effects — a landscape-level approach to planning is required in order to deal with a multitude of cumulative effects; and ecosystem paradigm is needed
- information — appropriate databases and good science is required to do a proper job
- legislation/process —

1. Need effective partnerships with Municipalities
2. Must have greater use of Memoranda of Understanding
3. Need to participate in Environmental Review Committees
4. Require options for delegation of *Fisheries Act* Powers to other levels of government
5. Should be refining the Land Development Guidelines
6. Require stream protection measures in *Municipal Act*, *Agricultural Act*, *Land Act*, etc.
7. Require stewardship incentives and punishment for private lands

8. Revamp referral process

- resources — changes in undertaking how the agencies do business will require additional funds and people, and the kinds of skills they will need
- accountability — monitoring, compliance and long-term commitments are required to ensure No Net Loss
- achieving No Net Loss — establish/identify milestones and approaches to achieving it in all habitats; evaluate No Net Loss on an ecosystem basis — process oriented; a Watershed Assessment Process (i.e., from top to bottom approach) should be able to measure effectiveness
- communication/awareness — there is a requirement to let the public and politicians know exactly what is happening

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Living Blueprint for BC Salmon

In 1998, the Living Blueprint for BC Salmon was published by eight independent volunteers who had had extensive experience in the field of fisheries throughout their careers. The document's attempt was to be a critique of what had happened in the field of salmonid habitat management and protection in British Columbia and to provide "much-needed province-wide policy and strategy on habitat management, habitat protection, stream restoration and salmonic enhancement."

Their assessment of what has happened to fish habitat in the last 50 years included:

- urban development had destroyed streams throughout the province including 50 out of 52 in the Greater Vancouver area
- diversion of water and removal of riparian vegetation for agriculture, thus, had affected fish habitat
- construction of roads and highways have impacted on streams
- hydro development on important fish producing rivers was an important contributing factor
- massive forest harvest, much occurring in areas of valuable salmon streams was also responsible

The Blueprint criticized the federal fish-habitat management program which has as its basis the "Net Gain" of habitat productivity but, in the view of the authors', in reality it falls back to its policy principle of "No Net Loss." Nevertheless, it also maintained that the Department of Fisheries and Oceans' fish-habitat policy has

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been instrumental in creating a heightened awareness of the importance of fish habitat although the implementation of the policy is a defensive rather than a pro-active response to chronic habitat loss; this is because it reacts to development projects and to instances of habitat damage.

The Blueprint also had criticism for the long-term or institutional/agency understanding of effectiveness of habitat management in British Columbia. Because the federal government has failed to conduct detailed pre-approval assessment of all development projects and to monitor all the activities affecting habitat across the province, in the report's view the habitat policies are not being implemented consistently. The authors suggest that the reason for this failure is that the federal government has not assigned a high enough priority to these activities. Even when mitigation or compensation for habitat loss is prescribed by regulators, the Blueprint maintains that the results are rarely properly monitored and evaluated.

What may be one of the more important points of the Blueprint document is that the authors recognize that we do not know how to compensate for all losses under all conditions and that this shortcoming heightens the importance of protecting the remaining productive salmon habitat. As a result, the Blueprint concluded, federal policy has not prevented habitat loss and degradation.

The Blueprint also commented on the provincial role in historic salmon and steelhead habitat loss. It recognized that provincially there is not a comparable overall policy like the Department of Fisheries and Oceans' Policy for the Management of Fish Habitat. Furthermore, it suggested that provincial policies intended to help prevent the loss of fish habitat, such as regulations under the *Forest Practices Code*, are not implemented in a systematic fashion, consequently neither federal nor provincial regulations and enforcement have been sufficient to protect critical fish habitat.

The Blueprint stresses that the remaining critical and significant salmon habitat must be protected if there was to be continued survival and protection of wild salmon. They suggested that agency spending priorities must include:

- proactive habitat management
- more effective enforcement
- strengthened habitat science
- more support for volunteers
- project-approval processes that are based on clear fish-production objectives

The authors argue that providing the basic regulatory foundations for effective habitat protection and adequate support structures is the highest-priority use of scarce resources. Therefore, the Living Blueprint document provides the overall recommendations that there should be:

- the development by all levels of governments of joint objectives for habitat protection
- the definition of effective watershed fish-production planning processes
- more effective priority-setting among all the activities involved in habitat protection (management, enforcement, monitoring, information, education and restoration), and enhancement, to improve co-ordination and program effectiveness
- the mutual reinforcement of the federal and provincial legislative frameworks

Groundwater Issues in British Columbia

The 1998 Environmental Trends in British Columbia Report provided information regarding the status of groundwater in British Columbia. Groundwater is an important part of salmonid habitat insofar as it is an essential component of the base-water in many of our salmon and steelhead spawning and rearing streams. While the report's primary issue related to water for human consumption, the trends have application to fish and fish habitat.

The report indicated that the percentage of provincial observation wells (150 across the province) with declining groundwater levels had nearly doubled over the past 30 years. The general trend towards declining levels is thought to be a result of increasing groundwater extraction on Vancouver Island and the Lower Mainland, changes to climate, and an increase in monitoring. In British Columbia groundwater users do not require a licence and approximately 600,000 people depend on this source of water and this is considered to be a source of contention.

In British Columbia there is a map-based system of classifying aquifers and currently there are 192 on that list. The groundwater supply in 90 percent of the aquifers is not at risk but it has been estimated that ten percent of the classified aquifers may be at risk due to heavy use. Furthermore, it has been suggested that about one-third of the classified aquifers are at risk to contamination from both natural and man-made surface pollutants. These issues of declining water availability and contamination may warrant further investigation from a fish habitat perspective.

Impacts to Gravel in Floodplains

While gravel is critical to the survival of salmon and steelhead for a variety of reasons, it has also been important to humans in the economic development of British Columbia. The aggregate industry uses a wide variety of sizes and types of gravel for road building and construction, and much of our early urban development was undertaken with gravel that was easily accessed from streams. For example, historically, significant amounts of gravel have been removed from some of our more notable salmon and steelhead streams including the Coquitlam, Alouette and Fraser Rivers.

Stream gravel is often a very convenient source of material and is usually of high quality. Furthermore, land-based sources are drying up due to the NIMBY (not in my back yard) approach taken to mining in suburban areas. In the United States 43 percent of the sand and gravel is used for residential and non-residential buildings, and 24 percent is used for building roads. For example, it has been reported that an average of 91,000 kilograms of sand, gravel and crushed stone is used to construct a six-room house and 14 million kilograms is required to build a house or hospital, while 59 million kilograms of aggregate is used to construct 1.6 kilometers of a typical four-lane highway. Transportation usually is the largest cost associated with the production of aggregate for construction.

Sand and gravel mining in streams can result in physical, chemical and biological effects. For example, this activity normally changes the geomorphic structure of the stream, often resulting in channel degradation and erosion. It also changes the channel geometry including changes in stream gradient and width-to-depth ratios. Point-bar mining increases the gradient by effectively straightening the stream. The relocation of the

deepest-part-of-the-channel often occurs when higher discharges reconnect the main channel to the extraction pit. On-site channel scouring and erosion can occur as a result of increased water velocity and decreased sediment load associated with mined areas. Upstream erosion, known as head-cutting can also occur causing dramatic changes to a streambank and channel that can affect bank stability, cover and siltation.

For some of the smaller streams it was very quickly realized that this gravel removal caused damage to spawning beds. However, until even recently, large amounts of gravel have been taken out of the lower Fraser River for the purposes of aggregate in the areas of some of British Columbia's largest pink salmon spawning runs. Furthermore, it has only been within the last decade that scientists have pointed out that the annual withdrawal of gravel often exceeded, and in some cases dramatically, the yearly recruitment of new gravel into the Fraser River.

While land-based sources of gravel are not easy to find, they can be used to replace river-based sources of aggregate. What is also troubling, however, is that the encroachment of humans onto the floodplains of some of our most productive streams has required massive diking and dredging of gravel from the stream channels in order to protect the properties in the riparian zone. Flooding is a common hazard to human property in British Columbia. Floodplains have historically been used for agriculture and urban growth and they are normally flat and easy to build upon and large floods in 1894, 1948 and 1972 caused damage to property in many parts of British Columbia.

Two commonly used "solutions" to this issue have been diking the perimeter of the private property and dredging of the river to increase the floodway capacity. Both options have negative impacts to fish habitat associated with their undertaking. In British Columbia there are 140 diking systems with a total length of over 1,000 kilometers protecting 120,000 hectares of land. In the lower mainland, 50 percent of the population and $13 billion worth of property and development exists behind 600 kilometers of dikes.

Some of these gravel-rich streams, such as the Vedder/Chilliwack and the Mamquam, historically had high rates of gravel recruitment. However, they had a very wide floodplain over which the river would meander and deposit its sediment, with few people living next to them prior to European settlement. Because the human population numbers have grown exponentially in British Columbia since the arrival of the Europeans, and land availability is at a premium, property development has occurred throughout the extremities of the floodplain and close to the wetted edge of the stream. As a result, for many of the circumstances the most common response to this phenomenon has been for the BC Water Management Branch and local Districts to permit or initiate dredging of the gravel to lower the stream bed and increase the flood-carrying capacity of the river.

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Federal Programs

Rebuilding the Resource: A New Approach to Salmon Habitat Program and the Federal Coho Recovery Plan

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Government-Linked and Non-Government

In June of 1998, the federal government announced the funding of a five-year $100 million Resource Rebuilding Program to provide a new approach to protecting and restoring salmon habitat. There are a number of strategies which are being put forward to the public including:

- the development of a permanent habitat fund from which the interest will be used to finance habitat restoration and enhancement projects
- fostering watershed groups who are involved in the stewardship of salmon habitat and who are assisting in addressing water and land-use conflicts
- the establishment of Habitat Stewardship Coordinators throughout British Columbia to promote public awareness of habitat and to assist community watershed stewardship groups to identify and assist in protecting habitat, implement habitat restoration and inventory projects, and salmon enhancement projects
- establishing Habitat Auxiliary Officers to assist planners, farmers and industry in making decisions with respect to fish. These Officers will also monitor compliance of developers in order to refocus on the protection of habitat
- the extension and augmentation of the Habitat Restoration and Salmon Enhancement Program (HRSEP) which was to end in 1998
- expand the 20-year Salmonid Enhancement Program

Within this program there is a stated vision, as well as guiding principles and program objectives. They are as follows:

Vision

- to develop partnerships to enhance habitat protection and expand community capacity to steward fisheries resources

Principles

- strategic delivery in priority watersheds
- scientific information exchange with stakeholders
- field orientated program design and implementation
- creation of long-term community stewardship capacity
- clear linkages with existing and effective habitat protection programs
- communication across governments, First Nations, industry and communities
- adaptive program that responds to local opportunities, abilities and fish benefits

Objectives

- incorporate fish habitat protection requirements into local land and water use plans
- increase public and stakeholders awareness of fish habitat requirements
- improve habitat mapping and inventory data required for land management and resource planning
- increase local stream surveillance and monitoring
- improved compliance monitoring of development projects
- provide technical information, advice and support to partners and communities
- pilot development of watershed management plans on several priority watersheds
- enhance and restore habitats as part of a watershed management plan
- increased community responsibility for watershed management

Salmonid Enhancement Program (SEP)

Conceived in the 1970s, the Salmon Enhancement Program (SEP) later changed its name to "Salmonid" in order to include steelhead when the province became a partner in the program. It was one of the largest programs to that date and continued from 1978 to 1988 with the stated objective of producing more salmon in British Columbia. While much of the early work was focused on production numbers and consequently hatcheries and spawning channels received the lions share of the money, habitat improvement and restoration was also a component of this initiative. Nevertheless, it has been argued by some that SEP hatchery production (for coho) or spawning channel enhancements (Skeena sockeye) have masked or exacerbated the declines in wild production by giving a false sense of understanding of the losses in habitat, or through the excessive by-catch in other fisheries. Thus, as a result, agencies and stewardship groups have remained less focused on habitat degradation than required.

One of SEP's main roles has been in the area of educating and involving the public on the role of salmon, hatcheries and habitat in small streams (e.g., the Public Involvement Program, PIP). By 1995 SEP and its network of Community Advisors had been involved in almost 300 small enhancement projects of which over 200,000 people had been involved with in one way or another. While the total production of fish from these small projects may not be considerable, it is felt that the sensitizing of local stakeholders to the importance of salmon and salmon habitat has been a key role. The public education initiative has allowed more informed communities to come to the various planning tables as stewards in order to lobby local politicians on the importance in protecting environmentally sensitive areas. The connection between the Department of Fisheries and Oceans and the groups was a Community Advisor who played a series of roles, the primary one often being of a technical nature (i.e., as a fish culturist). The downside to this part of the initiative is that many of the small hatchery projects may have done irreparable genetic damage to small stocks around the

province and reduced the focus on habitat restoration and protection.

Habitat Restoration and Salmon Enhancement Program (HSREP)

The Habitat Restoration and Salmon Enhancement Program (HSREP) was established in January, 1997 to complement the Pacific Salmon Revitalization Strategy and is a continuation of the Salmonid Enhancement Program (SEP). The primary objective of this three-year project is to increase the quality and quantity of salmon habitat in conjunction with conserving and the rebuilding of salmon stocks. The expenditures were to be $15 million and the program objectives were to support:

- resource and watershed stewardship
- habitat restoration
- salmon stock rebuilding

These three categories were designed to encourage community based stewardship with respect to salmon and habitat, increase the amount and quality of in stream and riparian habitat and rebuild populations using assessment and enhancement techniques.

In 1997/98 a total of $7.25 million was expended on 73 projects. Proposals were submitted from community groups, stakeholders and technical staff from the agencies. Projects meeting the funding criteria and employing displaced fishermen from communities affected by fleet rationalization were given a high priority. The deliveries of this initiative for 1997/98 is given in the table below.

Habitat production results of the 73 HRSEP projects for the 1997/98 fiscal year	
Habitat — stream and riparian (sq. m.)	220,728
Habitat — large woody debris (sq. m.)	4,600
Habitat — access upstream (sq. m.)	11,307,400
Riparian re-planting (# of native plants)	65,587
Fencing installed (linear m.)	16,750
Mapping — sensitive areas (linear m.)	443,247

The Salmon Enhancement and Habitat Advisory Board (SEHAB)

The Salmon Enhancement and Habitat Advisory Board (SEHAB) was formed subsequent to the 1976 signing by the federal and provincial government an agreement to cooperate on the establishment of the Salmonid Enhancement Program. Members of this Board represent a variety of sectors including commercial and

sports fishing, industry, tourism, First Nations, a variety of levels of government, educators and conservationists. SEHAB is a volunteer group that provides a forum for volunteer stakeholders to develop action plans and advise the government on:

- active, diverse enhancement programs through a range of projects supported by communities and volunteers
- strategies to manage salmon stocks, with conservation as a first priority
- comprehensive and effective habitat protection and restoration policies
- improved public understanding of the important environmental, social and economic benefits of British Columbia's salmon resource

SEHAB has been involved with initiatives that have fostered the successful "Salmonids in the Classroom" educational package. Other jurisdictions around North America have copied this successful program. SEHAB also regularly sponsors symposia and it was out of one of these gatherings that the Streamkeepers Program for British Columbia was born. SEHAB was also involved in the development of the highly successful Community Advisors who act as a liaison between Department of Fisheries and Oceans and the public. The Board also pushed for a change in policy from large hatcheries to smaller-scale, more natural developments.

Fraser River Action Plan (FRAP)

The Fraser River watershed was singled out in the 1990 federal government budget as requiring priority action because of the recognition of its high fisheries, ecosystem and environmental values. In 1991, as part of the Green Plan, the government established the Fraser River Action Plan (FRAP) as a jointly sponsored program of the Department of Environment and the Department of Fisheries and Oceans. In many ways the FRAP initiative was designed to include the whole Fraser River watershed and was to have a life of six years. FRAP's strategy included three main work areas including 1. Partnership building, 2. Clean-up of pollution, and 3. A restoration of natural productivity, which had the direction to:

- focus on ecosystems
- address the whole watershed
- work cooperatively and encourage partnerships, joint action and collective stewardships
- involve the public

Much of the work undertaken by the FRAP concentrated on contaminant and sediment issues in relation to their impacts on Fraser River watershed ecosystems and this was primarily conducted by the federal Department of Environment. Many of its studies showed how industrial and agricultural chemicals were being discharged into the aquatic environments and this work is helping the users come up with alternative methods for doing business while reducing impacts on the environment.

FRAP also interacted with, and supported, community groups, such as the Alouette River Management Society, Salmon River Roundtable, the Quesnel River Watershed Alliance, and the Nicola Watershed Community Roundtable, to address environmental and development issues in this watershed. Furthermore, FRAP assisted with other agencies and groups, through the Lower Mainland Nature Legacy Program and the Pacific Estuary Conservation Program, in the purchase of 441 hectares of wetland and associated upland

property for the protection of critical habitats.

The 1997 Auditor General's report on habitat indicated that with the end of the FRAP initiative on March 30, 1997 that a "large gap" had been opened up in the understanding of issues on the Fraser River.

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The Habitat Conservation Trust Fund (HCTF), formerly the Habitat Conservation Fund, is a sum of money that is obtained through fees attached to inland fishing, trapping, guiding and hunting licences. It is to be used, in part, for initiatives that protect, restore or educate the public about habitat and wild fish populations. Administered through the auspices of the Ministry of Environment, Lands and Parks and the Ministry of Fisheries, it expends approximately $5-7M per annum on various projects, of which just over half is on fisheries projects.

The objectives of HCTF are:

- to protect the habitat base of biological diversity and ecosystem integrity
- to appropriately conserve and, where necessary, enhance wild fish populations and their habitats
- to acquire, control and manage key habitats for fish and wildlife
- to increase public understanding and support for habitat-based ecological values in the Province
- to increase public awareness and support for the Habitat Conservation Trust Fund

The HCTF's legislative authority was introduced into law on July 30, 1996 by amending the Wildlife Act. Almost anyone can apply for money from the fund and its administrators encourage partnerships with other funding initiatives. Although HCTF is small compared to many such government initiatives, the fund is viewed by some as some of the best managed dollars-for-habitat and applied fisheries research in the province.

Historically the fund only gave money to issues which had a clear physical habitat development or restoration component. These criteria have been loosened considerably in recent years with the adjudicating bodies being aware of the linkages to applied research and the development of an understanding of what habitats to protect and how to protect them. The focus of the money also was on inland fisheries and steelhead and any salmon-focused projects were considered to be under the aegis of Department of

Fisheries and Oceans, and the Salmonid Enhancement Program, and did not usually qualify for funding. Nevertheless, considerable money has been spent over the lifetime of the fund where collateral benefits have been made for salmon habitat where the focus was on steelhead, sea-going cutthroat or other inland fishes.

The process involved in determining which projects get the money involves fisheries professionals from within the British Columbia Ministry of Environment, Lands and Parks and the Ministry of Fisheries, as well as stakeholders from outside of government, developing and submitting project proposals. These projects are first peer reviewed by professionals from around the province, and are then ranked using a variety of criteria including: order of importance to the fisheries program, technical and scientific quality, adherence to the terms and conditions of the fund. Finally, the projects are again ranked and vetted by the Public Advisory Board which is a volunteer group of individuals from a variety of academic and public areas with an interest in conservation biology.

With respect to salmon and steelhead, funds from the HCTF have been used for such projects as steelhead radio-tracking, development of riparian fencing on agricultural land, instream habitat restoration, as well as many other initiatives.

Watershed Restoration Program

In 1994 the government introduced, as one component of the Forest Renewal Plan, the Watershed Restoration Program (WRP). This was a response to the increasing pressure from both inside and outside of the province to how British Columbia had managed its forest harvesting over the last century with respect to fish habitat. The WRP's primary objective was to restore fisheries habitat that had been destroyed or impacted by historic logging practices. The budget for the first four years was slated to be $200 million and the money was raised from an increase in the stumpage rates. However the actual revenues for this work exceeded this amount but due to late startups, about $40-$60 million was expended per year with about $40 million and $20 million spent on hillslopes and streams, respectively.

Forest Renewal BC (FRBC), a Crown Corporation, administers the program while the agencies primarily responsible for the delivery of this program include Ministry of Environment, Lands and Parks and Ministry of Forests. WRP partners include forest licencees, First Nations, community groups and other government agencies, including the Department of Fisheries and Oceans.

The primary goals of this program were recently revised to provide a more fish-oriented direction. The 1999 goals for WRP include:

- restore and protect fisheries and aquatic resources in key watersheds throughout the province
- increase knowledge, information and tools for restoration and management of watersheds
- provide opportunities for community-based employment, training and stewardship

The program is attempting to re-establish conditions similar to those found in unlogged watersheds by imitating the processes that controls the physical and biological structures of the watersheds. The projects undertaken include hillslope stabilization, road deactivation and rehabilitation, riparian re-vegetation, fish habitat restoration and, in some cases, mitigation. Acknowledging the linkages between the physical and biological processes was put forward as the fundamental principle of this program, based largely on evidence

from hillslope and stream restoration programs over the past 10-15 years in the Pacific Northwest. A weakness of this program is that disproportionate amounts of money are often being spent on road deactivation and silviculture at the expense of fish habitat work; the former tend to be tied to providing forest companies access to wood rather than being ecosystem based.

WRP was meant to be largely "proponent driven" by the forest industry, First Nations, conservation and community groups, and government agencies. The hope was that partnerships would develop with stakeholders who have vested interests in rehabilitating resource values. In 1998, FRBC awarded multi-year agreements, largely to forest licencees and FRBC took over most financial aspects of the program. The agencies are now mostly involved in screening and setting technical standards whereas previously they had been much more involved in the actual delivery of the work.

Numbers of WRP stream and riparian assessment and restoration projects which were undertaken throughout all of British Columbia in the 1997/98 and 1998/99 fiscal years

	97/98	98/99
Channel Assessments	80	39
Habitat Assessments	566	147
Riparian Assessments	246	62
Culvert Assessments	39	212
Habitat-Channel Restoration	116	111
Riparian Restoration	18	42
Project Effectiveness Restoration	36	41

In the Pacific Northwest (Washington and Oregon), and British Columbia, 260 kilometers and 200 kilometers of streams are being rehabilitated annually, respectively, by replacing main channel large woody debris and restoring off-channel sites. The Watershed Restoration Program, in reviewing ten major stream-restoration projects in British Columbia and the Northwestern USA, found that the average cost of this work amounted to about $70,000 per kilometer.

Urban Salmon Habitat Program (USHP)

The Urban Salmon Habitat Program (USHP) is a provincial program for the management, protection, restoration and education of salmon habitat issues in urban environments. It was initiated in 1995. The USHP focuses in the area of the province where the threat to some stocks of salmon is most acute: the Georgia Basin. The USHPs five-year mandate is to ensure sustainability of salmon stocks by protecting and restoring habitats, building partnerships with other levels of government and First Nations, initiating

community involvement, and increasing public awareness.

The USHP was developed as three major initiatives. First was the encouragement of stewardship projects by providing funding and resources to community-based organizations for activities such as public education, habitat resource assessment, landowner contact programs, watershed planning, monitoring and evaluation as well as rehabilitation and restoration. The second initiative was to develop partnerships between the province, regional districts, municipalities, and communities through cost sharing for staffing. Finally, the third initiative was to raise awareness of conservation issues and stream-stewardship programs. The program provides the cost shared funding for the employment of environmental staff, and funds for community organizations to carry out specific urban salmon-habitat related programs in municipalities. In the Lower Mainland there are three full time staff including two individuals acting as community stewardship coordinators and one as a habitat liaison officer.

Department of Fisheries and Oceans and USHP have cooperated closely on a number of issues.

Fisheries Renewal BC (FsRBC)

The Fisheries Renewal BC Act created a Crown corporation in the province in 1997 with the mandate and authority to undertake programs and initiatives to promote the protection, conservation and enhancement of fish stocks and fish habitat. This legislation authorizes the agency to plan, invest and otherwise assist communities and the province in fostering fisheries sectors. Improving salmon and steelhead habitat is one component of the mandate that FsRBC is undertaking. One of three programs, the Salmonid Renewal Program is a primary initiative designed to deliver habitat restoration. Fisheries Renewal BC delivers its programs through community umbrella organizations.

As an example of some of the work that it is undertaking, in the upper Fraser Valley, in 1998-99 FsRBC allocated $300,000 for 14 initiatives including restoration assessment, watercourse and sensitive zone mapping, and clay-slide stabilization engineering.

Water Use Planning

Introduction

The relationship between impacts to fish habitat and power generation at hydro-electric facilities has received increasing consideration in recent years. In response to environmental and interest groups calling for greater protection for salmon and trout, the federal and provincial governments are now taking a stronger stance at hydro-projects. The result is that in November 1996 the provincial Ministers of Employment and Investment, as well as Environment, Lands and Parks, announced a creation of a Water Use Planning (WUP) process meant to revisit existing BC Hydro Water Licences to determine if changes could be undertaken in order to provide greater net benefits for British Columbia.

Background

An earlier review of BC Hydro system operations occurred in 1993 when the province directed the crown corporation to undergo an extensive Electric Systems Operations Review (ESOR) which was to determine if its electrical generation system operations could be altered to increase net social and environmental benefits for the province. Issues related to fish and fish habitat were analyzed for the whole province including those projects in watersheds where salmon and steelhead spawn and rear. The province then reviewed the report arising from this study and came to the following conclusions and direction:

- BC Hydro had more or less satisfied the terms of reference and objectives of the exercise with the exception of data on fish and aquatic resource impacts
- the present level of knowledge was not considered sufficient to determine whether there are significant opportunities for fisheries and aquatic ecosystem rehabilitation through changes to BC Hydro's system operations
- that a "System Operations Fund" be developed to deal with outstanding issues, including that to habitat, to address information gaps and to deal with outstanding flow and aquatic habitat impacts related to how the reservoirs, plants and streams were operated

While the implementation of the directions by the government to BC Hydro were slow to get underway, a series of other issues began to emerge which facilitated further activity in this direction. First, a Ministry of Environment, Lands and Parks and Department of Fisheries and Oceans audit of water usage of a number of BC Hydro's power generating facilities (see the descriptions of the Ward Reports in the previous chapter), where fish values were high showed non-compliance of a number of water licences. That is, potential water for fish was being used for other purposes.

Further Impetus

At the same time an issue surrounding the Stave Falls Replacement Project was emerging. A generating station at Stave Falls had been built around the turn of the century which required re-licencing subject to it being modernized. However, water passing through the Stave Falls Generating Station arises, in part, from a diversion of the adjacent Alouette River drainage. Public advocacy groups within the Alouette watershed decided that it was an appropriate time to take their concerns surrounding flooding and impacted fish flows to both the political level and to the Comptroller of other Water Rights.

Subsequently, a Water Use Plan was required, by the Water Management Branch, of BC Hydro for issues surrounding Stave Falls Redevelopment. The issues surrounding the Alouette River flows for fish and flood protection were to be addressed at the same time. The resulting successful consensus agreement as to how fish flows would protect fish habitat in the Alouette River provided the template for other WUPs for the rest of BC Hydro's Water Licences throughout the province.

Process

Water Use Plans will be prepared though efforts involving the licencee (BC Hydro) and government agencies, First Nations, key stakeholders and the public. Plans will be submitted to the Comptroller of Water Rights for review and approval. The goal of the WUP process is to achieve consensus on operating rules that satisfies

the range of water use interests at stake while respecting legal rights and other boundaries.

Water Use Planning is a process to enhance water management at hydro-electric power and other water control facilities in British Columbia. The purpose of a Water Use Plan is to:

- define the detailed operating parameters to be used by facility managers in their day-to-day decisions
- clarify how rights to provincial water resources should be exercised
- take into account of the multiple uses for those resources

The legislative authority to undertake a WUP is embodied in Section 31 of the Water Act where the comptroller of water has the authority to direct a licence holder that a plan be undertaken. When a WUP is required for existing licenced works, the outcome may be to recommend:

- a better definition of how water rights will be exercised over a range of conditions
- a modification to operations to bring a facility into compliance with regulatory requirements
- an amendment of the licence(s) to reflect the existing operations
- a voluntary change to operations resulting in a diminishment of water rights
- a reduction of licenced rights to reflect the extent to which the licencee has made beneficial use of the water

From a fisheries perspective, it is anticipated that much of the initiative will revolve around the re-release of water into streams where diversion has historically caused negative impacts on fish. However, is this process likely to work and is it going to be worth it? A prototype WUP, involving system operation changes and habitat enhancement, on the Stave River at the Ruskin Generation Station helped increase, in the period of less than a decade, an average run of about 30,000 chum salmon up to a 1998 escapement that was well over a half a million fish. This suggests that changes implemented by a WUP can have dramatic effects of fish habitat.

Protected Area Strategy (PAS)

While not specifically a fisheries initiative, the Protected Area Strategy (PAS) allows for the protection of whole ecosystems. Thus, it is becoming an important tool to protect the environment of which fish habitat can be a component.

The PAS is a set of policies which guide the selection and management of protected areas. In 1993 the provincial government took on the commitment to double the amount of protected areas in British Columbia from six percent to 12 percent by the year 2000. Since 1991 British Columbia has increased the amount of protected land from six to 10.6 percent. In the case of salmon and steelhead habitat, proposed or actually protected areas include Stein Valley, Kitlope, sites on the Lower Fraser River and Clayoquot as examples.

Wildlife Management Areas (WMAs)

Like the Protected Areas Strategy, the Wildlife Management Area (WMA) initiative designates areas for

protection, and although the primary objective may not be directed towards fish, salmon and steelhead often collaterally benefit as they are part of the particular ecosystem of interest. The WMAs do not normally exclude human activities to the level engendered by PAS, however, the use of the habitat by fish and wildlife is still the primary focus.

There are currently 18 WMAs in British Columbia with more on the way. Some of the more critical WMAs with high fisheries values include the Pitt-Addington area off of the Pitt River and the South Arm Marshes in the Fraser River estuary. Proposed new WMAs in the lower Fraser River provide some of the best opportunities to protect juvenile salmon rearing and there is some discussion to expand an existing site at the confluence of the Fraser and the Sumas River up the gravel reach.

Land and Resources Management Plans (LRMPs)

As part of British Columbia's Land Use Strategy, Land and Resource Management Plans (LRMPs) are being developed for various parts of British Columbia in order to rationalize the use of the province's natural resources including fish and fish habitat. These are higher-level planning exercises with the Land Use Coordination Office (LUCO) facilitating this work. The protection of sensitive areas is included in this work.

There are twelve LRMP processes underway or completed in the province and this covers 30 percent of its area. Public participation is a major part of an LRMP and these tables are designed to provide the government with a recommended local consensus or options for resource and land management. The plans will give government direction for management of land resources including fish habitat.

LUCO has stated that LRMPs are undertaken to:

- put sustainability principles into action
- provide opportunity to reconcile and balance policy goals and objectives with local demands
- address adverse effects of past resource development activities
- end disruptive community conflicts
- make more efficient use of scarce land and resources
- allow for opportunities to identify innovative practices
- provide certainty
- level the playing field
- provide a framework for operational planning and decision-making
- improve the long-term efficiency of administration

Canada/BC Agreement on the Management of Pacific Salmon Fisheries Issues

On April 16, 1997, the Prime Minister of Canada and the Premier of British Columbia signed a Canada-BC agreement on the Management of Pacific Salmon Fishery Issues which was intended to be the basis for a new partnership between the federal and provincial governments. As part of this agreement, a federal-provincial Pacific Fisheries Resource Conservation Council was to be formed to act as an overseer, in part, of habitat issues affecting salmon.

Part of the Agreement also included promises for stronger federal-provincial cooperation in protecting fish stocks and habitat restoration and protection through:

- a commitment by BC and Canada to provide new funds over three years to habitat and enhancement initiatives
- commitments to strengthen federal-provincial habitat protection legislation
- development of a new Habitat Protection and Fisheries Enforcement Agreement that will improve the coordination between federal and provincial field officers and focus resources on the areas of highest need in support of sustainable fisheries
- agreement to more actively involve communities and First Nations in resource protection activities in order to reinforce and supplement government's enforcement capacity
- providing a "single window" through which federal-provincial habitat and restoration programs are vetted

The Agreement states that the province and federal governments:

- share a mutual interest in conserving, enhancing and protecting the salmon resource, its habitat and the marine environment, that will help ensure a sustainable and viable fishery for the future It also states that the two governments will:
- develop joint objectives for habitat protection and commit to better program coordination
- work jointly in watershed fish-production planning processes to be structured in consultation with stakeholders
- strengthen habitat protection legislation

BC Hydro

British Columbia Hydro and Power Authority falls under the aegis of the provincial Crown Corporation Secretariat and thus can be considered a provincial entity. Mention must be made of BC Hydro regarding fish-habitat restoration activities that it has undertaken over the last decade to address some of its historical effects on salmon and steelhead. BC Hydro operates 30 hydro-electric facilities and 31 reservoirs in six major basins and 27 watersheds, although not all of them affect salmon and steelhead.

BC Hydro's Power Facilities Enhancement Program funds fisheries initiatives in order to address issues related to impacts on habitat, normally as a result of the footprint effects. Various types of work that BC Hydro has done over the years to address impacts to salmon and steelhead include creating spawning channels (Seton, Wahleach), placing spawning gravel in streams (Cheakamus, Campbell River), re-watering side channels (Cheakamus, Coquitlam, Alouette, Stave Rivers), adding flows (Wahleach, Alouette, Stave, Coquitlam, Bridge, Cheakamsu, Puntledge, Campbell, Shuswap, Heber, Salmon River), placement of large woody debris (Alouette, Stave Rivers) and removing fine sediments (Alouette River).

Of particular note is the smolt by-pass constructed on the Puntledge River. When the dam on this stream near Courtney was expanded in the 1950s the populations of salmon and steelhead began to decline. While a fish ladder to allow the fish to swim above the dam on the Puntledge was a partial solution, the young fish, while going downstream to the sea, were often killed as they swam through the turbines. To resolve this BC

Hydro put in place a sophisticated by-pass screen which allows 99 percent of the young fish to swim by without being harmed.

Another apparently successful project has been the recovery of chum salmon spawning populations on the Stave River. As mentioned earlier, for the power projects on the Stave River, BC Hydro in conjunction with the Department of Fisheries and Oceans and the Ministry of Environment, Lands and Parks, developed a flow regime which stabilized discharges to provide for flows that would protect fish and incubating embryos and alevins. Prior to this flow pattern, BC Hydro would follow the demand for power in the Stave/Ruskin generating stations which would mean that there was often little or no flow for part of the day and a high discharge when there was a high demand for power. The negotiated fish-friendly flow regime has allowed populations of chum salmon to rebound in the Stave River downstream of Ruskin from about 30,000 fish in the late 1980s to over 0.5 million spawners in 1998.

Point-Source Water Contaminants

Pollution-control measures for point-source water contaminants include the 1992 pulp mill effluent standards initiated by the provincial government. These were designed to eliminate AOX discharges (chlorine bleaching by-products) by the year 2002. Between 1988 and 1994 the pulp and paper industry in British Columbia reduced it's AOX releases by 80 percent, and in the Fraser River, the discharges of dioxins and furans had been reduced by 98 and 92 percent respectively.

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Stewardship Projects

Rebuilding the Resource: A New Approach to Salmon Habitat Program and the Federal Coho Recovery Plan

First Nations are becoming more involved in the issues of habitat restoration and protection. In the lower mainland the Skyway (Chilliwack), Musqueam (Vancouver) and Katzie (Maple Ridge) Bands have all been involved in salmonid projects of note.

Aboriginal Fisheries Strategy (AFS)

The Aboriginal Fisheries Strategy also has been making a contribution to habitat conservation and protection. In 1995-96 there were 23 habitat projects undertaken with a total cost of $800,000. Much of the work is being done in the south-central interior of the province where there is a need to address issues related to coho declines in escapement. For example, the Nicola Watershed Stewardship and Fisheries Authority (NWSFA) receives its core funding from the AFS and it is involved in a wide variety of restoration projects including stream-bank restoration, re-vegetation, development of salmon rearing channels, and assessment and inventory.

Government-Linked and Non-Government Organizations

Fraser River Estuary Management Plan (FREMP)

The Fraser River Estuary Study was a scoping group formed by Canada and the province in 1977 in an attempt to deal with the alarming rate of estuary loss on the Fraser River. The Study included work on water quality measurement and habitat area designations. Out of the study groups came the 1978 habitat committee's report on the state of the estuary which called for a no net loss approach to protecting habitat in the estuary given the amount of habitat that had been lost since the arrival of Europeans.

Subsequent to the release of this report, and a number of interim working groups that put together a plan

framework, the Fraser River Estuary Management Plan (FREMP) was formed in 1983. It currently supports an environmental planning exercise that provides direction for those involved in the management and protection of the Lower Fraser River from Kanaka Creek to the Strait of Georgia, and includes Boundary Bay. Its aim is to provide for the safeguard of habitat values yet still permit industry and communities to undergo their business on or around the river.

Partners in this planning exercise have varied but now include six agencies: Canada Department of Fisheries and Oceans; Canada Department of the Environment; BC Ministry of Environment, Lands and Parks; Greater Vancouver Regional District; North Fraser Harbour Commission; Fraser River Harbour Commission. Although various agencies sit at the table, legislation specific to habitat (e.g., Canada Fisheries Act) still applies; that is, FREMP does not circumvent legislation and policy with respect to the protection of habitat but links the planning to the legislation and the authorizing agencies.

FREMP describes itself as an initiative similar in scope and purpose to a municipality's official community plan. The Estuary Management Plan was first initiated in 1979 with area designations. Department of Fisheries and Oceans lobbied for further development to color coding of habitat in 1987-90. As part of the upgrade of the FREMP process, a more comprehensive plan was put in place in 1992 when agencies, industry and non-governmental organizations came together to put forward a better way to manage the Fraser River estuary. The Plan fosters understanding of the estuary issues and coordinates partnerships between government, business and community. It tries to develop consensus on how the water, shore and upland areas of the estuary will occur. Habitat management and recreation are integrated with water quality, water-dependent development, log management as well as navigation and dredging.

The Plan attempts to do the following:

- provides common basis for reviewing development proposals in the estuary
- outline local planning and resource management actions that will guide current and future water, shoreline, and upland use of the estuary

From a strategic perspective, the Plan is devised to bring together:

- ongoing FREMP programs and guidelines
- the plans of municipalities and port authorities
- the management activities of federal and provincial governments
- policy and programs of the Greater Vancouver Regional District's Livable Region Strategic Plan

BC Heritage Rivers Board (BCHRS)

The BC Heritage Rivers Board (BCHRS) was established in 1995 to officially recognize and protect the province's most important rivers. The rivers that were recognized originally included such key salmon and steelhead producing streams as the Fraser, Cowichan, Adams, Babine and Stikine rivers. A public Board was appointed by the government of BC and it established a public consultative process, identification criteria and selection guidelines for the identification and assessment of candidate rivers. The public and its opinion guide the Board in which rivers to nominate as Heritage Rivers. Support for the program has come from communities, local governments, industry, First Nations and individuals in areas where the rivers actually

exist.

The goals of the BCHRS are:

- to identify and recognize provincially significant rivers for their natural, cultural heritage, and recreational values
- to encourage a greater focus on provincially significant rivers in the appropriate land use planning process
- to promote greater public awareness and improved stewardship of all rivers throughout the province

Fraser Basin Council

The Fraser Basin Management Board was created in 1992 by the federal and provincial governments and its mandate covered the geographical area of the Fraser River watershed. As one of its final acts before being disbanded, the Fraser Basin Management Board issued a Charter for Sustainability, which articulated a vision of the Fraser Basin as a place of social well being supported by a healthy economy and environment. The Charter provided the stage for the creation of the Fraser Basin Council which was announced in February, 1997.

The Fraser Basin Council is a not-for-profit non-governmental organization with representation across a wide variety of interests. It encompasses 36 members including persons from the federal and provincial governments, the regional districts in the Basin representing 65 municipalities, the eight linguistic and cultural groups among the 96 First Nations in the Basin, the five geographic sub-regions in the Basin, and the business, labor, environmental and social sectors. The Council has no direct power but facilitates and coordinates the use of existing government and non-government authorities. There are five regional staff members throughout the Basin who undertake a variety of activities.

Stewardship Groups

The influence of community stakeholder and stewardship groups has been one important component in the management, protection and restoration of fish habitat in British Columbia for some time, including such long-time groups as the BC Wildlife Federation. However, with the advent of the Salmonid Enhancement Program in the 1970's, and the Urban Salmon Habitat Program, and their incorporation of community involvement, many new stakeholder and stewardship groups have started to emerge as a force with a lot of potential to affect decision making by governments. This is particularly in the case of the Lower Mainland where the largest human population numbers are concentrated although such groups can be found throughout the province.

One of the best reviews on the subject of watershed stewardship groups was undertaken by Howard Paish in the 1997 Department of Fisheries and Oceans/Fraser River Action Plan sponsored report entitled "Stream Stewardship and Fish Habitat Advocacy: an assessment of current and potential community group involvement in the Lower Fraser Valley." In this report Paish summarizes the growth and spectrum of various stewardship entities which are currently involved in salmon habitat stakeholder/stewardship activities.

The overall summary of the report contends that habitat protection in British Columbia is essentially a political exercise and that advocacy by stakeholders is critical in maintaining fish populations in the face of growing populations and habitat degradation. Furthermore, few stewardship groups understand the governmental and legal tools available to them to ensure that planning, decision-making, protection and restoration are taking place by the role agencies. Within the spectrum, and specific to the lower mainland (although the observations can be extended to other areas of the province, particularly south-eastern Vancouver Island), the Paish report outlines the following:

Community Groups

Community groups encompass a wide range of entities that are formed for the protection and restoration of streams and watersheds. Some of these groups arose out the support from the Salmonid Enhancement Program, Habitat and Enhancement's Streamkeeper initiative as well as the Fraser River Action Plan and the Fraser Basin Management Board. In the Lower Mainland Paish estimated that there are about 100 and includes small groups of a handful of people to large groups such as the Langley Environmental Partners Society, which is a coalition of organizations in the township of Langley, and the Alouette River Management Society, which includes over twenty interests.

Many of these community groups fall under the aegis of the Pacific Streamkeepers Federation (see below for more details). These groups tend to be hands-on although strong advocacy does occasionally occur through groups, the Alouette River Management Society being an excellent example. The potential strength of these groups arises due to the fact that they are dealing with a habitat resource in their own back yards, and to which they have a personal link; in particular, this gives them the legitimate option of being able to influence land planning decisions that are under the legislative authority of their respective municipal governments.

Naturalist Groups

Nine naturalist clubs can be found in the Lower Mainland and they belong to the province-wide Federation of BC Naturalists. While their objectives are broader than fish, the protection of aquatic habitat is a key component of the work that they do, and they have the venue to undertake ecosystem protection, which can be much more forceful way of protecting fish habitat than a streambank-by-streambank approach. Naturalist groups also tend to get involved in advocacy when it is clear that a development will impact on an ecosystem under their purview. An example of such a naturalist group in the lower mainland is the Burke Mountain Naturalists.

Fish and Game Clubs

Fish and Game clubs have existed in British Columbia for many decades. Their original intent normally involved the harvest of fish and game rather than protection and advocacy. However, as fish and game became more scarce as a function of habitat degradation, some of the clubs began to embark on stream restoration and hatchery projects.

In the lower mainland there are 20 such clubs. The BC Wildlife Federation acts as the umbrella organization

linking these groups. Clubs that have had a strong history of dealing with habitat issues include the Port Coquitlam Hunting and Fishing Club (Coquitlam River), the Sapperton Fish and Game Club (Brunette River) and the Semiahmoo Fish and Game Club (Little Campbell River).

Some of these groups have become highly political (BC Wildlife Federation) and are strong advocates for specific issues. The Steelhead Society of British Columbia is of particular note in this regard. While they originally dealt with governments as an advocacy group focusing on steelhead harvest and habitat issues, they have now branched out into a habitat corporation which performs the role as a salmon and steelhead restoration entity.

The Pacific Streamkeepers Federation

The Pacific Streamkeepers Federation is a non-profit society that supports over 150 community groups involved in stream and fish enhancement throughout British Columbia. The Federation is supported by the Canada Department of Fisheries and Oceans, the BC Ministry of Environment, Lands and Parks, and the Pacific Salmon Foundation. Its objectives are:

- to provide and information exchange for streamkeeper/enhancement groups
- to assist in coordinating efforts in streamkeeper/enhancement issues
- to facilitate education and training
- to facilitate the initiation of new and like-minded stewardship groups
- to facilitate the support of existing streamkeeper/enhancement groups
- to foster cooperation amongst stakeholders that impact on watersheds
- to promote the management of aquatic resources at the local level

Much of the technical support for Streamkeepers comes from the Department of Fisheries and Oceans' Community Advisors and the provincial Urban Salmon Habitat Program. The "Salmonids in the Classroom" program is one which the Streamkeepers have been associated with and been very successful undertaking.

Watershed Pledge Program

The Burnaby Lake System Project is an initiative co-ordinated by BCIT to manage and restore the Burnaby Lake Watershed aquatic ecosystem. As part of this effort it is developing a Watershed Pledge Program whereby homeowners and businessmen, which potentially contribute to the contamination of the aquatic ecosystem as a result of everyday activities (e.g., vehicle washing, lawn fertilization, contaminants from parking lots), could be educated regarding their opportunities to change this type of behaviour and commit from doing these sort of actions through means of a Pledge. The program would also target local schools, advertise in the community, be part of community events, and undertake an audit of compliance.

Outdoor Recreation Council (ORC)

Dam Decommissioning

British Columbia has almost 50,000 Water Licences or applications outstanding. Many of these Water Licences are attached to a dam which diverts and/or stores water for hydro-electricity, domestic water supplies, flood control and other purposes. Some of these dams are old and have outlived their usefulness. Other dams are still being used but the value of the fishery resource that they have impacted upon on now outstrips the productivity of the dam. Finally, there are some dams which should not be in place simply because the public decides that it is inappropriate.

Recently there have been dam removals in British Columbia, such as this past year's Whiskey Creek decommissioning to return a Vancouver Island stream back into coho production. However, most of these dam removals have been small or for safety reasons. ORC now believes that it is time to initiate the next step in removing outdated dams for more significant recoveries.

The Outdoor Recreation Council (ORC) has been supporting the removal of dams that appear to have impacted streams with high fisheries values and could have restored habitat values as a result of the removal of the project. Three such dams in the province that ORC has been supporting a review for are on the Heber River on Vancouver Island, the Wilsey Dam on the Shuswap River in the central interior, and the diversion dam on the Theodosia River at Powell River. The Heber River is tributary to the world famous Gold River and its summer and winter steelhead runs; the Shuswap River was dammed at a cascade where the Wilsey Dam is now situated, but it has been demonstrated that chinook salmon, and perhaps other species, historically migrated upstream of the cascade. Finally, the Theodosia River salmon runs appear to have been heavily impacted by the diversion of almost all of its water into the Powell River Watershed and the historically large numbers of fish seen in the lower river now no longer return to spawn.

Rivers Day

BC Rivers day is an event that is organized by the ORC and has done much to increase awareness throughout the province. It attracts up to 30,000 participants who take part in activities ranging from stream clean-ups to fish enhancement projects. There is now an effort by ORC to turn this into a national event within the next few years.

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